DOCUMENT RESUME

ED 042 354 EM 008 345

AUTHOR	Hagerty, Nancy K.
TITLE	Development and Implementation of a Computer-Managed Instruction System in Graduate Training. Technical Report Number 11.
INSTITUTION	Florida State Univ., Tallahassee. Computer-Assisted Instruction Center.
SPONS AGENCY	Office of Naval Research, Washington, D.C. Personnel and Training Branch.
PUB DATE	30 Jun 70
NOTE	182p.
EDRS PRICE	EDRS Price MF-$0.75 HC-$9.20
DESCRIPTORS	*Computer Assisted Instruction, Curriculum Development, *Graduate Study, Program Descriptions, Programed Instruction, Systems Approach

ABSTRACT

A graduate level course was developed and tested using the techniques of computer-managed instruction (CMI) to teach the techniques of programed instruction. The CMI system included diagnostic testing, remediation, data collection, and record keeping. A study guide, independent of the computer, directed the student to textbooks and other printed materials. A systems approach was used to develop the instructional materials for the course. The instructional logic included a motivational game in which the student bid points on his estimate of how well he could perform on a unit test. Two experimental variables were introduced into a study of the course--student choice of the unit sequence versus computer presented set-sequence and computer-facilitated evaluation of the written product versus instructor evaluation. Appendices present materials described in the paper, such as behavioral objectives, test items, evaluation instruments, bibliography, questionnaires, and program procedures. A glossary and reference list are provided. (JY)

CAI CENTER

TECH REPORT

DEVELOPMENT AND IMPLEMENTATION OF A COMPUTER-MANAGED INSTRUCTION SYSTEM IN GRADUATE TRAINING

Nancy K. Hagerty

Tech Report No. 11
June 30, 1970

Project NR 154-280
Sponsored by
Personnel & Training Research Programs
Psychological Sciences Division
Office of Naval Research
Washington, D.C.
Contract No. N00014-68-A-0494

FLORIDA STATE UNIVERSITY

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Florida State University Computer-Assisted Instruction Center Tallahassee, Florida 32306	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Development and Implementation of a Computer-Managed Instruction System in Graduate Training

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Report No. 11, June 30, 1970

5. AUTHOR(S) (First name, middle initial, last name)

Nancy K. Hagerty

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 30, 1970	161	33

8a. CONTRACT OR GRANT NO. N00014-68-A-0494 b. PROJECT NO. NR 154-280 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Personnel & Training Research & Program Office of Naval Research Washington, D.C.

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The investigation of CMI using student-terminal interaction was motivated by the high cost of conventional computer-assisted instruction. This approach minimized student terminal time, yet incorporated the best aspects of CAI, namely the individualized pursuit of goals, self-pacing and immediate feedback, with automatic record-keeping. (continued on next page)

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

FORM 1473 (BACK)
DD 1 NOV 65
S/N 0101-807-6821

Security Classification
A-31409

ABSTRACT - continued

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A systems approach was used to develop instructional material used with the CMI system. A conventionally taught course on the systematic design of instructional materials was task analyzed, and behavioral objectives were written for the specific tasks (units). Test items consistent with the objectives were written and entered into the computer.

The student received a study guide containing a task description, behavioral objectives, and relevant references for each unit. At the computer terminal, he received the test for each unit and remedial information if he failed to meet criterion. If a written product was required for a unit, he also received the criteria for judging the accuracy of that product. The student then chose the next unit to study, bid on that unit, and was signed off. The two experimental variables used in the study were student choice of the unit sequence versus computer presented set-sequence, and computer-facilitated evaluation of the written product versus instructor-evaluation. Extensive appendices present examples of the materials described in the dissertation, such as behavioral objectives, test items, bibliography, evaluation instruments, questionnaires, and BID procedures.

The course, Techniques of Programmed Instruction, was run by CMI in the Fall of 1969 at the Florida State University, with 59 graduate students. The students worked at their own pace by scheduling time on the computer terminal within predetermined hours. The students tended to seek aid from the teaching assistants and fellow students rather than from the course professor.

The results indicated that the CMI students performed as well as students taught the previous year by conventional class-lecture methods. The group of students who chose their own sequence tended to perform better than the set-sequenced group on the midterm test and final product evaluation. They also had higher attitude scores toward CMI and took less time on the terminal. However, none of these differences were statistically significant.

Developmental costs included acquisition of references and instructional materials, and development and implementation of the CMI logic. This cost was $9,297.00. Costs of operating the course, for terminal time and personnel, were $3,074.00, which is much lower than the costs of a comparable traditionally taught class.

Future use of the interactive, terminal-oriented CMI system developed in this study extends to the development of similar courses which can be evaluated in an equivalent manner, as well as to further studies of the effectiveness of this course.

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(Publication No.)

Nancy K. Hagerty, Ph.D.
The Florida State University, 1970

Major Professor: Walter Dick

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ACKNOWLEDGEMENTS

Many thanks are due the following:

Dr. Walter Dick for his patience and longsuffering through the development of this dissertation.

Dr. Duncan Hansen for his critical assistance.

Dr. Henry Lippert for his attention to details.

Dr. Bobby Brown for his continuing the work begun here.

Dr. Don Driggs for his support and acceptance.

Mrs. Betty Wright for help in preparing the computer presentation.

Mrs. Sharon Papay and Edna Reynolds for their help with details.

Mrs. Louise Crowell, Mrs. Dorothy Carr, and Mrs. Ann Welton for their preparation of the course materials.

Mr. Dave Danner and the other machine room personnel for their efforts in preparing the data for course evaluation.

The Students who gave their time in the development of the project, especially "Dr." Paul Gallagher, and to those who suffered through the field test, thank you.

And to my husband and three children who gave beyond that usually required of a family,

Laugh, kindly, quietly at all
The serious souls who can't.
There is little in this quick life
Worth an ulcer.

N. K. Hagerty

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CHAPTER I

INTRODUCTION

Technology today is no less praised nor criticized than it was in the educational institutions of over 100 years ago (Belanger, 1968). Only the focus has changed. Then it was blackboards and world globes which came under attack; today it is the computer (Oettinger & Marks, 1968). Unique to the computer era are two major explosions, one of knowledge and the other of population (Bushnell & Allen, 1967). More has been learned about science alone in the last 20 years than was learned in the previous 20 centuries. Today's students must be able to use more information than at any other time in history. At the same time, twice as many children stand in need of this education. Yet rather than adjust to the need, too many educational systems are continuing to teach the same material in the same manner.

Thorndike (1931) and Dewey (1916) were educational revolutionaries in the early part of the present century. Dewey, who was more acceptable to educators than Thorndike because of his emphasis on education for democracy (Hilgard, 1964), placed great emphasis on the individual in the educational process. Educators, while accepting Dewey's ideas for individualized education, apparently lacked the means

of putting them into operation. Theoretical emphasis was upon the individual, yet practice never seemed to adjust for it. In the early 1900's several plans were proposed and implemented (Drake, 1955) which allowed children more freedom and individual responsibility for their own learning. The Dalton Plan (Parkhurst, 1922) and the Winnetka Plan (Washburne, et al., 1926) were two examples. But, here again, the educational system was not yet ready to launch individualized instruction on a large scale. Then, early in the 1950's, the Air Force recognized the need to reorganize military research, development, and personnel management to produce a better instructional system (Gagné, 1965). The result of this reorganization became what has been termed the "systems approach." Educators who have long recognized the importance of individualized instruction, saw the potential for using the systems approach to education to organize the learning environment in the schools. Every aspect of the educational process is considered part of a total system geared to individualizing this process and thus producing educational outcomes superior to those produced before.

Problem to be Investigated

The technology is available to assist teachers and students in the learning process. Individualized instruction is a method of allowing for differences in students and helping each student perform to the best of his ability. In addition, the systems approach has been used to develop instructional materials in a more scientific manner. Given these factors, one must decide how to use them to better the educational process. Computer-assisted instruction (CAI) has been offered as a

solution, but costs seemingly are prohibitive at this time (Mitzel, 1967). Computer-managed instruction (CMI) has been proposed as a means of using the computer in the educational process more economically, but at least four major problems are evident.

First, there is little consensus as to the definition of CMI. The second problem is the question of how one develops and implements materials for a CMI system. A third problem is the redefinition of roles of the instructor and the student, caused by the reallocation of functions taken over by the computer. And fourth, how feasible is a CMI course in terms of hardware and software availability? These four problems are investigated in the present study in terms of general feasibility of using CMI in a graduate level course of instruction.

It is necessary to define CMI before showing how the system works. Computer-managed instruction can be defined as an automated approach to individualized instruction that performs five functions (Hansen, 1970). It includes diagnostic evaluations and learning prescriptions. It can counsel students about adaptive learning strategies and appropriate career development. It can be used to develop an optimal scheduling system to match students with learning resources. It can keep records of instruction and student learning performance. While CAI encodes learning materials within the computer system, CMI relies upon a rich variety of conventional printed and multi-media materials. CMI uses the capability of a computer to manage the progress of a student through a program of instruction, testing that progress at many points.

In the present study, CMI has been defined in terms of the components of the system involved, i. e., testing, diagnosis, remediation, and recording information. In addition, students benefit from the immediate feedback capabilities of a computer, so feedback in conjunction with testing (as distinct from instruction) becomes an extra function of the CMI system. There was no direct instruction via the computer in the experiment described here. Evaluation items encoded within the computer were presented as part of the student-terminal interaction, followed by diagnosis and remediation.

These four components are usually the function of the course instructor. In the CMI course delays usually caused by the instructor's time allotments are not evident. Students are immediately informed in regards to their status in the course and what they should do next.

Briggs* has supervised a survey of alternate models for the design of instructional materials toward the end of individualizing instruction. CMI does not necessarily demand new instructional models, but a new approach may be needed in using existing ones. To develop the instructional materials for the course, one systems approach was implemented as it would have been for any course of instruction. The primary difference was the manner in which the materials were used. The media were available to the student for individualized, self-directed study, while the tests on each learning unit were presented via the CMI system.

Five special questions about scheduling and the recording of

*Unpublished collection of seminar review papers written by students in EDR 631, Winter Quarter, 1970, at the Florida State University.

student functions were explored in detail in the field test of the course

1. Scheduling: How many terminals would be needed when scheduling is determined by the students?

2. Student Performance: What would be the relative efficiency of student control of the learning situation when compared to instructor control?

3. Student Attitudes: What attitudes would students have at the end of the CMI course and how would they perceive the role of the instructor of the course?

4. Logistics: In moving from theory to practice, could all of the desired components of the CMI system be implemented?

5. Cost Factors: What would it cost to develop CMI and operate the CMI course as compared to conventional instruction?

To answer the question concerning student control versus instructor control of the learning situation, two experimental or independent variables were used, the sequence of instruction and the evaluation of the materials developed by the student. The sequence variable allowed some of the students to choose the sequence of course units, while others followed a computer controlled sequence. The evaluation variable allowed students to rate their own performance on instructional materials they had written based on computer presented criteria versus instructor ratings based on identical printed criteria.

In summary, problems relating to the development of a computer-managed course of instruction were investigated before the actual

experiment. The CMI components were defined, as well as the method of developing the materials and questions to be answered by the field test.

CHAPTER II

SURVEY OF THE LITERATURE

This chapter presents the close relationship between CAI and CMI. The former deals with instruction presented on a computer terminal, while the latter refers to the management of a course of study via a computer-driven terminal. Both use the same equipment, which is costly, and both transfer some of the teacher's traditional roles to a machine. Both CAI and CMI offer possibilities and problems never encountered before in mass education. Both can be used in the process of individualizing education. This individualization process is aided by use of instructional games.

Hickey (Ed.) (1968) makes the observation that CAI is an inevitable outcome of the trend toward individualized instruction, of the proliferation of information to be acquired, and partly an outcome of teacher shortage. On the other hand, Mitzel (1967) states that CAI lacks credibility as an instructional tool because of its cost, the shortage of good CAI programs, and a lack of detailed plans for continuing use of CAI programs.

Gerard (1967) points out that CAI encourages updating of the instructional materials, thus benefiting the teacher, and provides more opportunity for teacher-pupil contact. Hansen (1968, p. 178) gives

the following aspects of CAI which make it applicable to the individualized instruction process: "attentional processes, feedback and correctional procedures, retention and transfer and evaluation techniques."

However, Cooley and Glaser (1969, p. 95) have said, "Before any fruitful discussion can begin on how the computer might facilitate such education, it is necessary to make explicit just how individualization is to be accomplished." They state further that individualization is "adapting instructional practices to individual requirements (p. 95)." The adaptation is, in fact, the teacher's recommendation as to how to use packaged material for each student. This is termed individually prescribed instruction (IPI). The teacher determines the course of instruction and the goals, then offers the student a limited choice of materials from which he selects those he feels will help him reach predetermined goals. The choice given to the student is based on the teacher's estimation of the alternatives which match the student's learning profile. IPI is therefore instruction prescribed for a given individual, based on his initial capabilities, with less concern given to the student's own desires about those goals.

Esbensen (1968) points out that individualized instruction incorporates independent study in varying degrees, depending on the ability level of the student and the course of study. Other requirements for individualized instruction are that the student moves at his own speed (Esbensen, 1969), that the entering behavior of the student match the entry requirements of the course (Gagné, 1967) and that the student chooses his own goals. Of the latter, McDaniels

(1968, p. 242) comments: "Youth are not too young to choose, only too poorly prepared to make choices."

Sears (1940) studied expectancy levels of students and their ability to make realistic choices using predetermined goals. From her study it appeared that when a student was successful, he chose realistically, while the same student, if told he was unsuccessful, chose erratically.

Individualization requires organization of the instructional materials, according to Bushnell and Allen (1967). Gagné (1968) proposed a task analysis based on a learning hierarchy to facilitate that organization. He feels that students learn by steps, and if a task is accurately analysed a student will not be able to pass the objectives for any given step unless he has passed the objectives for each preceeding step. Dick (1969) adds to this the use of the systems approach in the development of instructional materials.

The work of Cooley and Glaser (1969) and Esbensen (1968) points out the inordinate amount of paper work involved in running an individualized system that met the above requirements. In exploring the uses of computers in IPI, Cooley and Glaser (1969) state, "The computer cannot be justified if it is simply used to keep records." Even though it decreases the need for clerks, it is still more expensive than the clerks, they argued; but if one can incorporate other features into the use of the computer, then it might be justified.

Computer-managed instruction can incorporate features other than recordkeeping. Current CMI programs are in the research and/or development stages. In 1969, Morgan (p. 100) cited the following

CMI projects in progress:

> Harry Silberman's work with the Southwest Regional Educational Laboratory and the Los Angeles Public Schools; Robert Glaser of the University of Pittsburth working with the Oakleaf School in Pennsylvania; Donald Torr of Sterling Research Institute, Don Tosti of Westinghouse Learning Corporation and Alexander Schure of New York Institute of Technology all of whom are working with the U.S. Naval Academy. All of these projects are sponsored by the U.S. Office of Education. Another large project involving CMI is headed by John Flanagan under the sponsorship of the American Institute of Research and Westinghouse Corporation.

The New York Institute of Technology has operated a system in which data processing is all off-line; all evaluation is handled by multiple card input. Output records are prepared only upon request for specific information. As an integral process, students use CAI programs, but the use of CAI course material is not part of the CMI system. Data which are generated by the CAI course are fed into the CMI system, off-line (O'Dierno, 1968).

Systems Development Corporation (Coulson, 1968) uses a similar CMI system, in that evaluation tests for off-the-shelf materials are answered on machine-scorable answer sheets, which are periodically optically scanned and scored by the computer. Each day, lists of data are supplied to the teacher, informing him of the location of each student in relation to his objectives and the status of the class as a whole. The system is available to the teacher for interrogation on any student as the information is needed.

Glaser's IPI began without the use of automation (Cooley & Glaser, 1969). The clerical tasks encountered during the first three years of operation helped clarify what data were available and suggested how they were to be used. This made it easier, according

Cooley and Glaser (1969, p. 105) to define their CMI system which

> is called IPI/MIS, the IPI Management and Information System. . . The basic data are recorded on optical scan forms by clerks located throughout the school. These forms are brought together and processed at the IBM 1232 optical scanner. The resulting punched cards are then read by the terminal at the school and the data edited and added to the current student file on disk at the computer. . .
>
> There are four major functions which the MIS can provide in an individualized school: (1) collect data; (2) monitor student progress; (3) provide prescription information; (4) diagnose student difficulty.

Flanagan (1970, p. 2) identifies five components of the Project PLAN CMI system as "(1) A set of educational objectives, (2) Learning methods and materials, (3) Evaluation, (4) Guidance and individual planning, and (5) Teacher development." Concerning the use of the computer in this CMI system, Flanagan (1970, p. 5) states that "most of the daily processing involves the transmission of module test cards and the return of related messages to the terminal after central processing has been completed." Further reports are then generated at set times during the year and are used to guide the student through his academic activities.

Morgan (1969, p. 100) summarized these CMI systems.

> These studies differ in a variety of ways such as reliance on off-the-shelf materials as opposed to developing new instructional resources. They also address different academic levels and areas. Their similarities are greater than their differences, however. All are designing learning interventions based on carefully specified behavioral objectives and all are using the computer to mediate between the student, his individual performance on the objectives and the inventory of instructional resources related to the objectives.

The role of the teacher appeared to change or be changed by the CMI systems in operation. In Glaser's (Cooley & Glaser, 1969) IPI

system, introduction of the computer relieved the teacher of some of the paperwork and prescribing. In the system at the New York Institute of Technology (O'Dierno, 1968) the teacher assumed less of a teaching role in certain subjects (those taught via the terminal), but remained in the traditional role in the others. There is no definite statement in any of these studies as to what the role of the teacher was or should be in a CMI course.

Instructional games could be a part of the CMI course, and assist the individualized learning process. Nesbitt (1968, p. 1) claims that games "seem not only to involve the student and absorb his interest but also help him learn better than do other methods." The primary intent, according to Boocock and Schild (1968, p. 14) is "to arouse interest and to motivate students to further study." Their description of the use of games is concerned with incorporating a game into a learning experience or using it in a counseling situation. Esbensen (1969) has used BID (see adaptation in Appendix A) as both a motivating and monitoring device for the total learning situation. Students contract for points, based on their assessment of their own abilities, in much the same way as a business man contracts for work in the real world. Esbensen (1969, p. 8) states that "the major purposes of BID are (a) to give each player practice in trying to assess correctly his ability to accomplish designated learning tasks, and (b) to increase each player's motivation to accomplish the learning tasks."

In summary, an investigation of CMI systems indicates that those in operation utilize the recordkeeping aspects of CAI capabilities, but fail to take advantage of immediate feedback capabilities or

in any way use the computer as an interaction tool. The increase in individualized instruction has emphasized the need for organization of educational materials and the development of behavioral objectives. Games are used in the educational setting as motivational tools, and can transform the entire learning situation into a game context. The role of the teacher in an individualized, CMI situation has not been defined, but does not appear to be the same as the role of the teacher in a traditionally taught class-lecture situation.

CHAPTER III

DEVELOPMENTAL MODELS

In order to implement a CMI course, it was first necessary to develop both the instructional materials and the programming logic for the computer system. Dick's (1969) Model for the Systems Approach to the Development of Instructional Materials was chosen as a guide to develop the instructional materials, since it was felt that it was both concise enough and sufficiently developed to be appropriately implemented. The CMI components were defined and then the immediate feedback logic for the CMI course was developed.

Systems Approach

Dick's model represents a cybernetic system, as illustrated in Figure 1. The steps in that model were used as follows:

1. The conventional graduate course in programmed instruction was chosen for development.

2. By task analysis, the hierarchial arrangement of skills necessary to meet the terminal objective of the course was determined.

3. Prerequisite skills and knowledge of the students were established.

4. The terminal objective and subordinate tasks were specified as behavioral objectives which defined the observable behavior of the

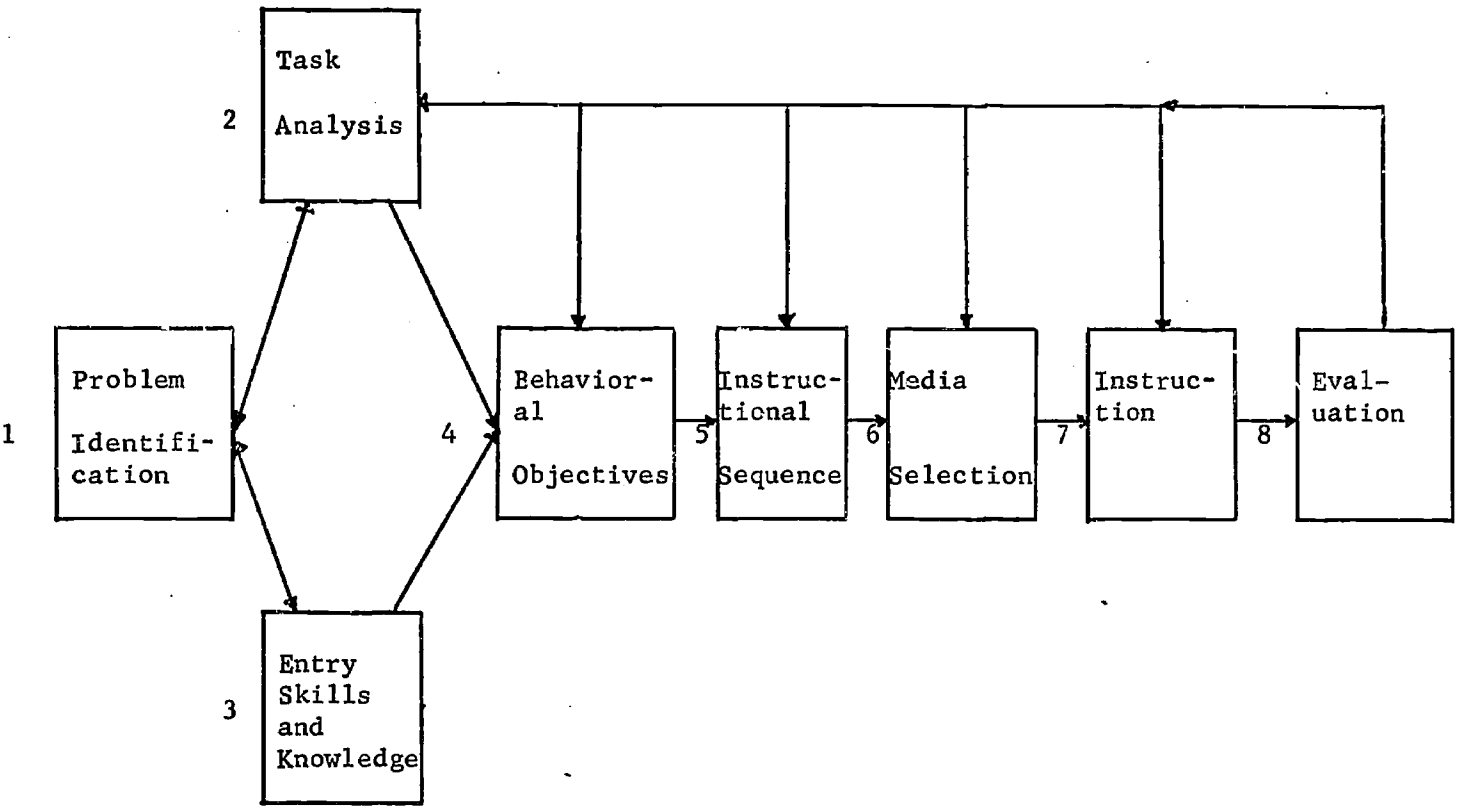


Figure 1. Model for the Systems Approach to the Development of Instructional Materials (after Dick, 1969).

student and the conditions under which his behavior was to be demonstrated. Evaluation items consistent with the behavioral objectives were written.

5. The instructional sequence which was to be managed by the computer was designed.

6. Available PI texts, journal articles and typed materials, with a limited number of materials written specifically for some of the objectives, were obtained for each objective in the course.

7. Instruction consisted of individualized, self-directed reading of reference materials, group discussions, instructor-student interaction, and use of instructional games. Students were ramdomly assigned to experimental groups as were appropriate to the design of the course.

8. Constant evaluation of both student and system as instruction proceeded presented information for analysis of prior steps and for improvement of the system as a whole.

A detailed discussion of the steps of that model as they were used in the development of the course is presented in Chapter IV.

Computer-Managed Instruction Logic

The CMI systems discussed in Chapter II use the same basic logic in that all learning is done off the computer; tests and the evaluation of their results are performed off-line, and the results are available in printouts on a delayed basis. In the present CMI course, student-terminal interaction was necessary to provide the student with

immediate performance feedback.

Basically, the logic of the CMI course which was developed was as follows:

1. Identify the learning unit to be studied by the student.
2. Give the student a test on that unit.
3. Diagnose areas of weakness according to errors made on the test.
4. Provide the student with remedial information.
5. Pass him onto the next unit when he reaches criteria.

In summary, Dick's (1969) systems approach to instructional design was used to develop the instructional materials for the course, while the CMI system used the components needed to implement a graduate level course of study. Those components consisted of on-line testing, diagnosis, remediation, and record keeping. The logic provided a systematic flow from one unit to the next.

CHAPTER IV

DEVELOPMENTAL PROCEDURES

The steps presented in Dick's model were used in preparing the instructional materials for the CMI course. The documentation of that development will be presented in this chapter, as well as the computer logic for the CMI system.

Development of Instructional Materials

Problem Identification

The choice of a course for implementation was based on several considerations. One, the course should be an ongoing one, providing for future use of the materials. Two, it should be one whose content is fairly stable. Three, the course must be one which could be evaluated using objective questions. Four, it must be one with which the author had sufficient knowledge to develop and implement. The course chosen in line with this set of criteria was Techniques of Programmed Instruction (identified as EDR 537), taught each fall and spring quarter at the Florida State University.

This course had been taught by the traditional class-lecture method, three hours a week. Students were taught the systems approach (Dick, 1969) and expected to use it in the development of the product

they were required to write for the course, a programmed instruction (PI) text. The evaluation of that product took place at the end of the quarter. The instructor performed both the product evaluation (using a set list of criteria) and final examination evaluation. This final examination was an essay type question dealing with uses of programmed instruction.

The course material developed for implementation would consist of the same basic information required of previous classes. Greater emphasis would be placed on the cognitive aspects (specific knowledge required of the student), with periodic tests to evaluate how well the students were learning the steps required to write a PI text. Product evaluation at each of those steps could assist the student in accurately developing his PI text, while the final document evaluation would determine the student's grasp of the entire systems approach rationale. Both the cognitive and productive evaluations could be managed by the computer, while the final document evaluation would be performed by the instructor due to the type of evaluation required.

Task Analysis

The task analysis in Figure 2, which was developed for the programmed instruction course, outlined 20 units to be completed by the student. The tasks, as identified by the analysis, represent the skills needed by the student in order to write a PI text.

Figure 2 distinguishes between the two types of performance required of the student. The units in the task analysis are specifically defined as cognitive and/or productive units, indicating

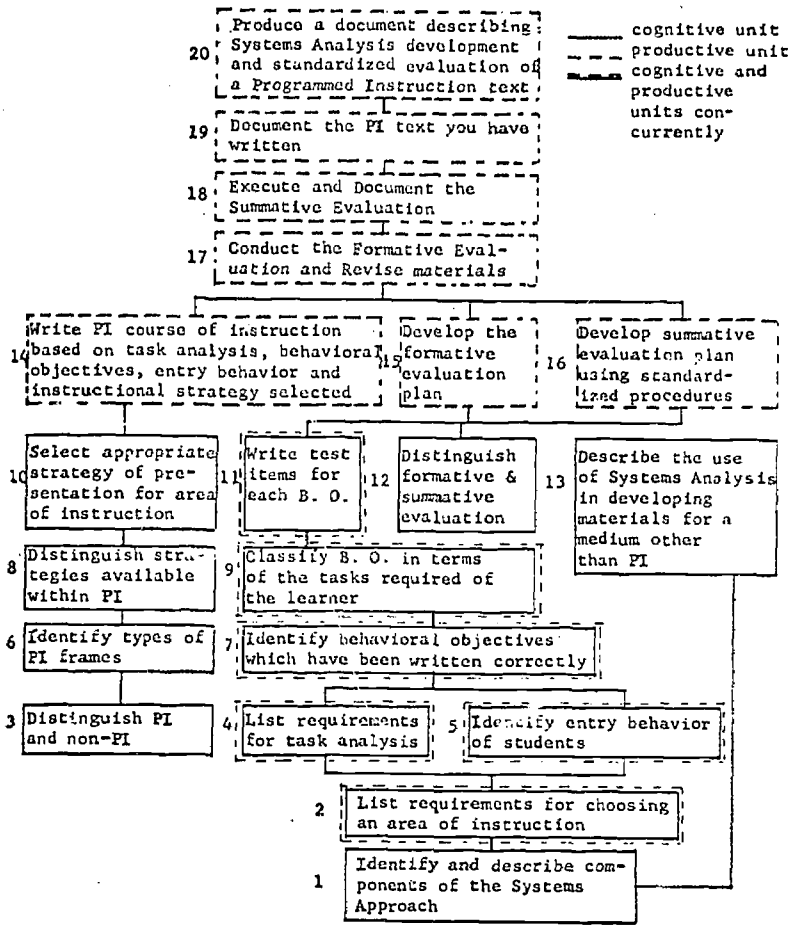


Figure 2. Task Analysis of Techniques of Programmed Instruction, showing cognitive and productive units.

respectively those units which require learning basic concepts and information and those which required use of the concepts to write a product. For the first 13 units, some form of learning which could be evaluated must take place, whereas Units 14 through 20 required use of that information. This is represented in Figure 2 as solid lines for the cognitive units, broken lines for the productive units, and both solid and broken lines when both cognitive and productive events must take place.

Entry Skills and Knowledge

Students who were to take the course were graduate students with the basic abilities implied by that status. It was assumed that they would be familiar with the formalities of documentation and would be able to document their PI text development.

In terms of prerequisite knowledge, the students were required to have a major interest and background in at least one content area, such as statistics, music, or social studies, in order to write the PI text required for the course.

Behavioral Objectives

The tasks were further defined in terms of one to three behavioral objectives which contained the expected behavior of the student, under what conditions, and to what level of proficiency. While complete mastery is desirable, an 80% criterion was decided upon to allow for testing errors.

To illustrate the materials developed for this course, Unit 7, which deals with behavioral objectives, has been selected. The unit

objectives are presented on the contract sheet in Appendix B.

Evaluation Items for Behavioral Objectives

For each cognitive behavioral objective there were approximately fifteen questions written of which a student would receive a random selection of five. This would permit a new set of questions for retests and permit an 80% criterion; the student would receive remedial information only if he missed more than one question out of five for each objective. A test for a unit contained five, ten or fifteen questions, depending on the number of objectives (1, 2, or 3) for the unit.

The test items were either true-false or multiple-choice questions. These were not pre-tested for reliability or validity, but were presented to three experts for their professional judgment whether the items measured the intended objectives. Sample test items for Unit 7 are presented in Appendix C.

A pre- and posttest were developed which required students to recall information specific to each objective. These were alternate forms (see Appendix D and E, respectively) covering the cognitive material in Units 1 through 13. The computer tests required students to choose correctly from given alternatives, while the pre- and post-test (midterm) required short answers and completions.

For each productive behavioral objective a list of criteria was prepared which contained questions relating to the product the student was to write. For example, a student working on Unit 7 would write behavioral objectives for each of the steps in his task analysis.

The criteria questions he would receive for this productive unit are presented in Appendix F. These questions helped the student determine if he had actually done what was required.

The product evaluation sheet (see Appendix G) which was used in prior years to evaluate the documentation written by the student on his PI text was also used for this CMI presentation. No changes were made in this evaluation so that comparisons could be made between this course and the 1968 class products.

Instructional Sequence

Under traditional instruction, the steps in the systems approach (Figure 1) were presented in sequence, from one through eight. The task analysis included separate units for specific parts of each step in the systems approach. This task analysis, based on Gagné's (1968) hierarchial learning theory, presumes that a lower unit on the task analysis must be learned before any higher unit can be learned. Therefore, the units were numbered from the bottom up, with the task of Unit 1 being to "Identify and describe components of the Systems Approach," and of Unit 20 to "Produce a document describing Systems Analysis development and standardized evaluation of a Programmed Instruction text."

Media Selection

The decision to limit the media aspects of the PI course to texts and articles was based on limited time for their investigation and/or development. Though there were films, slides, and video tapes available, these were not used.

References were selected which met the requirements of specific behavioral objectives; books, articles, journals, papers and pamphlets. In most cases, specific pages from these sources were referenced in a student study guide. Texts and reports prepared by the students who took the course in prior years were also made available. A bibliography was distributed which contained all the references for the course.

Contract Sheets

When the unit descriptions, behavioral objectives and references were completed for each unit, they were incorporated into a contract sheet, as presented in Appendix B. This contract sheet was the basis for the student's bid. He was to read the objectives for a unit and estimate how well he could perform on the unit test. By so doing he was contracting for that unit. He would earn the points if he passed, or be penalized if he failed the test.

Instruction

The study guide for the PI course contained an introductory page, task analysis, flow chart, contract sheets, Unit 20 evaluation criteria, a bibliography, and the BID procedures. Only an introductory and summary lecture were prepared. Students were free to request lectures, small group discussions or any additional help needed as the course progressed.

Instructional Game

An unsuccessful search for an appropriate instructional game began early in June, 1969, and continued into October, 1969. A suit-

able game would have had to aid in the learning of a unit in the PI course, and assist prospective teachers to understand the normal instructional situation in the classroom and how it can be realistically and positively changed.

Case studies which had been written initially for another game were used. Game proceudres were developed around those case studies and the result was COMMENT (Hagerty, 1969), a game which used both learning taxonomies and the systems approach to learning. Directions were completed, then reviewed by three assistants to determine if the game would in fact be instructional.

This game was available for use by the students during the run of the course.

Evaluation

Results of the evaluation for this course are presented in Chapters VI and VII.

Development of CMI Logic

The programming logic necessary to implement CMI was developed in line with the task analysis and computer systems requirements of the IBM 1500 instructional system. Limitations built into this CMI course logic are discussed, as well as the type of remediation presented. Experimental elements and validation checks which were in the computer presentation are also described in this section.

The flow chart in Figure 3 shows the route taken by the student through a learning unit. The components chosen for this CMI system consisted of testing, diagnosis of weaknesses, remediation,

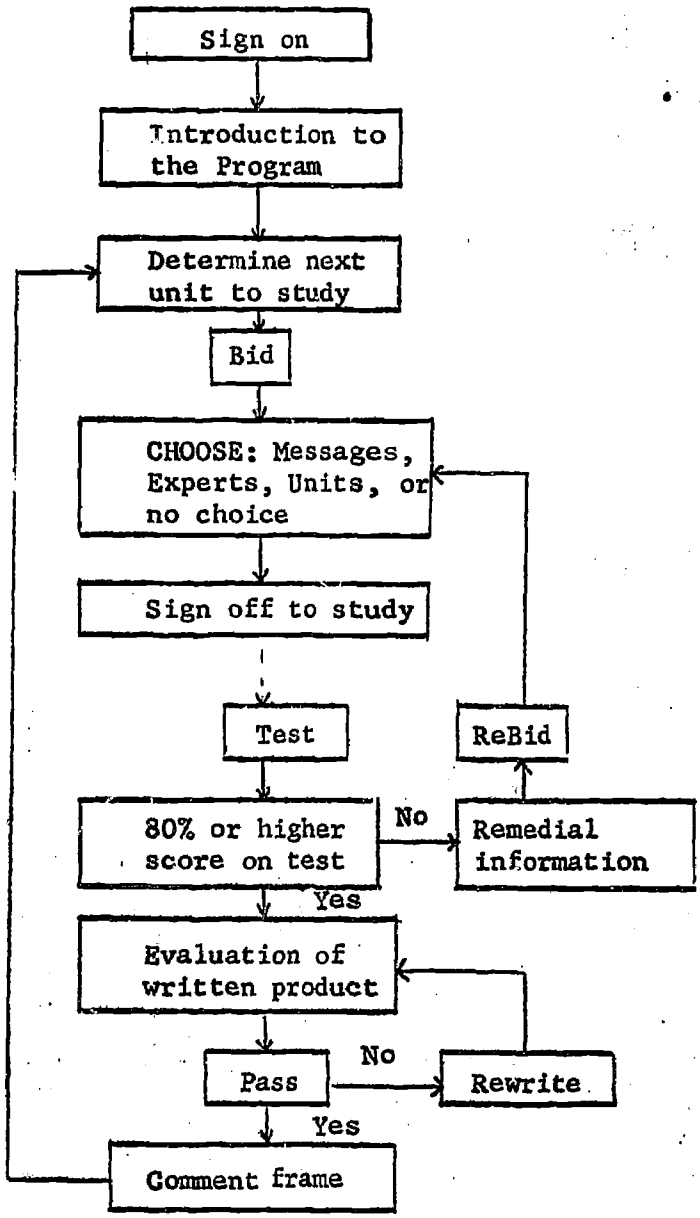


Figure 3. Flow Chart Showing Student's Progress Through CAI Course lesson.

and recordkeeping, but excluded the presentation of instructional material. Therefore, the primary flow of a lesson, as indicated by Figure 3, was from the unit presentation and bid, to study, test, and evaluation of the written product. Remediation was given when there was poor test performance on a behavioral objective or when a student had failed the productive criteria for the unit.

The order of presentation for experimental group branches and miscellaneous entries in the program is presented in the flow chart in Appendix H.

The CMI logic which was developed could be utilized to implement any course which could be similarly evaluated. The limitations imposed on this program by the author may be overcome without a major change in the logic. Present logic permits from 1 to 20 units, from 1 to 3 objectives per unit, from one to five random selection of questions from an unlimited pool, and unlimited product criteria. Each learning unit, consisting of from one to three behavioral objectives, was entered as a separate segment on the computer.

Questions for each unit objective were limited to five, which allowed for the 80 percent criterion. Total questions which could be entered on the program, from which the five are selected, is limited only by disk space (5 million characters).

Criteria questions relating to the productive objectives were presented in a linear mode. Since the record kept did not identify correct or incorrect responses, an unlimited number of criterion questions could be entered for each productive objective.

When the logic and typing errors for Unit 1 were eliminated (debugged), the program coding on that unit was copied (duplicated on the computer system) as 19 additional segments. Deletions to adjust for less than three behavioral objectives and less than 45 test items required further logic adjustments for each unit (segment). Test items were then entered in the appropriate units. There were no test questions on Units 14 through 20, therefore the game BID was not used past Unit 13.

An example of a dialogue between a student and the computer on Unit 7 is presented in Appendix I. Each unit from 1 to 13 was basically the same, while Unit 14 through 20 contained criterion questions, but no test questions.

Remediation

Responses to the test items for each objective were required before the student could proceed. If the response was incorrect, it was counted and the correct answer indicated. After all objectives for a unit had been completed, the counter was checked. More than one error for an objective called up the message, "You should study the references for Behavioral Objective (1)."

Remedial assistance was minimal since the intended population were graduate students. The references for each unit were presented on the contract sheets; the student chose those he wished to study. By failing a unit test, the student was made aware that he either had chosen references incorrectly or had not studied sufficiently to pass the test. He then decided whether to redirect his study or change

his study pattern for that unit.

Miscellaneous Computer-Presentations

Several additions to the course were provided which were a part of the experimental or control aspects, but not part of the PI course itself. The control entries were provided to protect the integrity of the data generated. These additions are presented next and in Appendix I.

Since the student was given control of the program presentation in several places, checks were provided to him which indicated if he had signed on to his own program and which unit test he would receive. For example, when a student signed on, he was presented, "This is the program for (name). Have you signed on to your own program? a. Yes b. No." If the student had inadvertently signed on to someone else's program, he chose "b," and was signed off to try again. If it was his program, he chose "a," after which he was presented, "You will now be given the test on Unit (5). Is that correct? a. Yes b. No."

If he had studied for the Unit 5 test, he would choose "a" and proceed to the test. However, if he had studied Unit 3, or already taken Unit 5, he would indicate "b." He would be branched to the choose frame where he could choose Units and be presented with a display of the units chosen to date by him. If he seriously questioned the presentation, he could call the proctor who would adjust the course settings. Otherwise, he would continue with the unit test.

A "Choose" frame asked, "Do you wish information on any of the following? . . ." This frame allowed the student to choose to see any messages which were prepared for the class, the names of students who had completed the unit on which the student was presently working, and a list of units he himself had completed so far.

Because a study on learner characteristics and CMI was conducted simultaneously with the operational phase of this project (Gallagher, 1970), an anxiety scale (Spielberger, 1966) and appropriate branches were entered on each unit. Course logic indicated that a student would receive the anxiety scale, test, and productive criteria as presented in Table 1.

TABLE 1

ORDER IN WHICH THE ANXIETY SCALE, TEST, AND PRODUCTIVE CRITERIA WERE GIVEN FOR THREE TYPES OF UNIT ARRANGEMENTS

Cognitive Unit	Cognitive and Productive Unit	Productive Unit
Anxiety Scale	Anxiety Scale	
Test	Test	
Anxiety Scale	Anxiety Scale	Anxiety Scale
	Productive Criteria	Productive Criteria
	Anxiety Scale	Anxiety Scale

A section was included on each unit which asked the student, prior to taking the test, which references were studied and which were of the most value and least value in studying for the test. The student was instructed to type in the number of selected references as they appeared on the contract sheet for that unit. This information was used in evaluating the references prepared for each unit.

Additional information as seemed appropriate was entered for each unit. For example, in Unit 4, the student was told that the second behavioral objective test questions required a handout. Unit 13 indicated that BID would not be used for Units 14 through 20, and presented the student with his total bid score to date.

A comment frame was presented after the completion of each unit. Students were given 10 lines, 40 characters long, in which they could type any statements they wished. The comments were to be used in evaluating the course as it progressed, and were used in final evaluation of the course.

Debugging

After all test items were entered on the computer, each test item was examined on the computer terminal for inconsistencies, errors, or misunderstandings which could develop because of the display of the question. A student experienced in programmed instruction and two other graduate students familiar with test construction assisted in this process. Revisions were made as necessary. During the first two weeks of class, further revisions were made in inproper wording and incorrectly coded questions.

The first four units were debugged just prior to the time the first few students encountered those units. Debugging of the remainder of the course preceeded the students by a greater margin. The researcher and programmer concluded that, upon completion of the debugging, the program logic was working as it should and the students would be able to proceed as planned.

In summary, the development of the PI course materials was facilitated by the use of the systems approach. Development of CMI logic using testing, diagnosis, remediation, and recordkeeping components was accomplished, and the PI materials were entered on the computer.

CHAPTER V

RESULTS OF DEVELOPMENTAL PROCEDURES

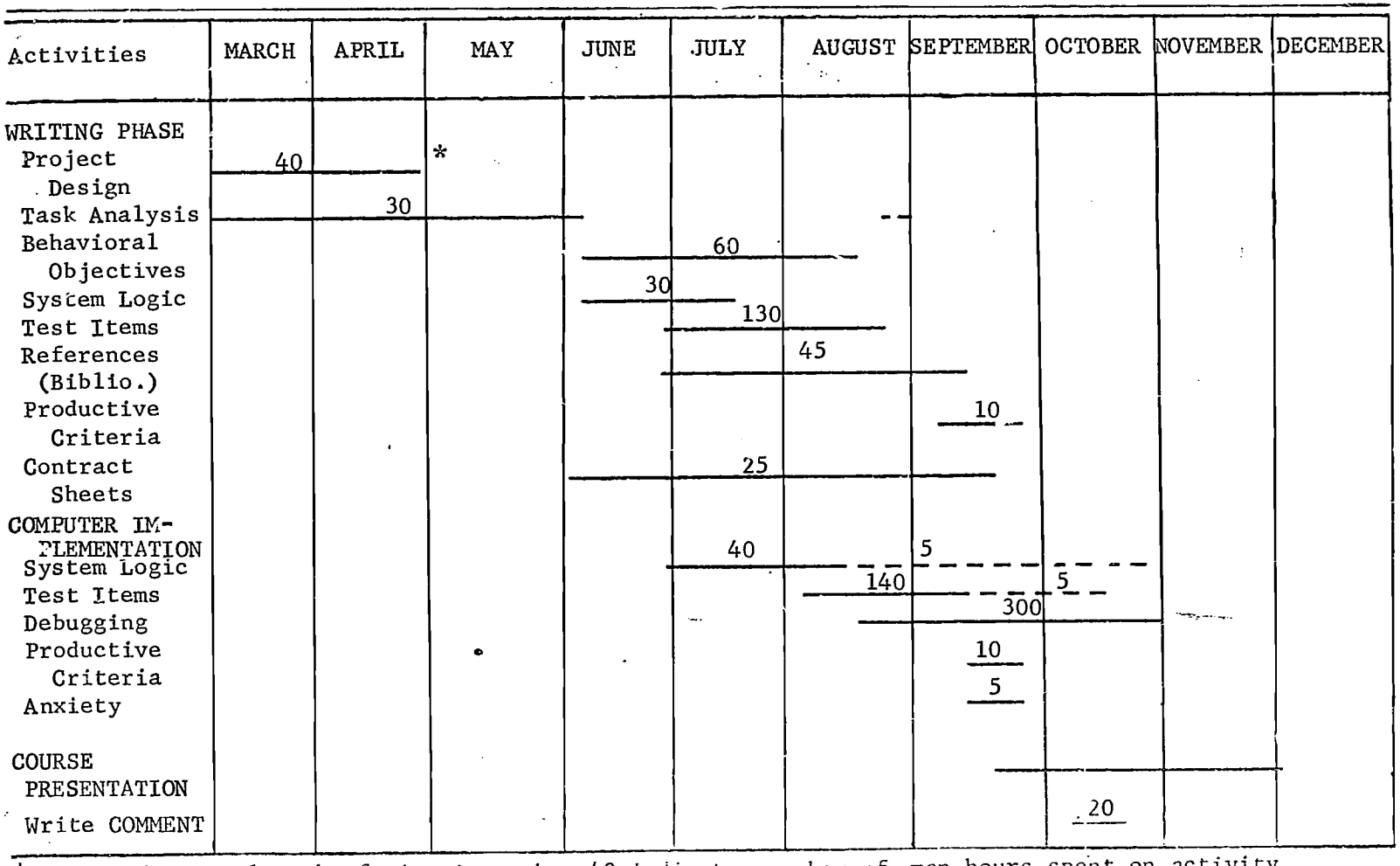
The development of a course of instruction and the logic for CMI presentation of that course was documented, with time and cost factors detailed, as well as results of the developmental procedure. These will be presented in this chapter.

The developmental phase covered the dates from March 1, 1969, through Noverber 7, 1969. An examination of Table 2 will show how many weeks an activity took, as well as the hours actually spent on that activity. The task analysis was developed during the months of March, April, and May, 1969, and required approximately 40 man-hours of work. Upon completion of the task analysis early in June, the behavioral objectives were written along with the test items for the cognitive objectives and the criteria for the productive objectives.

CMI logic was completed by the middle of July. At that time the program was entered on the computer. By the first of August the program was working well and the test items for Unit 1 were entered. Debugging began in August with Unit 1 and continued through Unit 20, which was completed by the last of October. A total of 875 man-hours was utilized in preparing the CMI course to the point where it was an usable management tool.

TABLE 2

TIME SCHEDULE OF ACTIVITIES FOR THE DEVELOPMENT OF THE COURSE, TECHNIQUES OF PROGRAMMED INSTRUCTION, USING COMPUTER-MANAGED INSTRUCTION



* _____ indicates length of time in weeks; 40 indicates number of man-hours spent on activity.

Table 3 presents the activities of individuals involved in implementing the CMI course. This includes the work of this researcher, three assistants, the programmers, and the secretarial staff. Actual minute-by-minute records were not kept, but hourly estimates were recorded. The course itself covered the dates from September 29, 1969, through December 8, 1969. Costs per activity are also recorded.

Development of the materials for the CMI course took approximately 280 hours time, while development of the CMI logic in Coursewriter II language required another 70 hours. At a cost of $4.00 per hour, development of materials and logic cost approximately $1,400.00. Entering the material on the system took 205 hours, while debugging that material took 300 hours. At a cost of $15.48 per hour (computer programmer costs at FSU CAI Center, 1968), total computer work cost $7,817.40. Secretarial time involved in typing the handout cost $80.00. Total developmental costs for this CMI course were approximately $9,297.00.

When the units, test questions and product criterion had been entered on the system, there were a total of 20 units, with 22 behavioral objectives and 316 test questions. Fourteen of the units required a written product while six did not. This is presented in Table 4.

TABLE 3

TIME AND COST UTILIZATION IN DEVELOPMENT AND IMPLEMENTATION OF CMI COURSE

Activity	Time (in hours)				Total Time (Hours)	Cost (in dollars)					Total Costs (Dollars)
	Researcher	Assistants	Programmers	Secretarial Staff		Develop Material ($4/hr)	Debug Logic ($4/hr)	Enter Material ($15.48/hr)	Debug Material ($15.48/hr)	Secretarial ($4/hr)	
DEVELOPMENTAL PHASE											
Project Design	40	--	--	--	40	--	160.00	--	--	--	160.00
Task Analysis	30	--	--	--	30	120.00	--	--	--	--	120.00
Behavioral Objectives	40	20	--	--	60	240.00	--	--	--	--	240.00
System Logic	15	--	15	--	30	--	120.00	--	--	--	120.00
Test Items	90	40	--	--	130	520.00	--	--	--	--	520.00
References	40	--	--	5	45	160.00	--	--	--	20.00	180.00
Productive Criteria	5	5	--	--	10	40.00	--	--	--	--	40.00
Contract Sheets	10	--	--	10	25	40.00	--	--	--	60.00	100.00
Subtotal	270	65	15	20	370	1,120.00	280.00	--	--	80.00	1,480.00
COMPUTER IMPLEMENTATION PHASE											
System Logic	5	--	40	--	45	--	--	696.60	--	--	696.60
Test Items	60	--	85	--	145	--	--	2,244.60	--	--	2,244.60
Debugging	100	100	100	--	300	--	--	--	4,644.00	--	4,644.00
Productive Criteria	--	--	10	--	10	--	--	154.80	--	--	154.80
Anxiety Scale	--	--	5	--	5	--	--	77.40	--	--	77.40
Subtotal	165	100	240	--	505	--	--	3,173.40	4,644.00	--	7,817.40
TOTAL	435	165	255	20	875	1,120.00 (280 hr)	280.00 (70 hr)	3,173.40 (205 hr)	4,644.00 (300 hr)	80.00 (20 hr)	9,297.40

TABLE 4

NUMBER OF UNITS, COGNITIVE BEHAVIORAL OBJECTIVES, TEST QUESTIONS AND PRODUCTIVE BEHAVIORAL OBJECTIVES WRITTEN FOR THE CMI COURSE

Unit	Number of Cognitive Behavioral Objective	Number of Test Questions	Number of Productive Behavioral Objectives
1	1	15	--
	2	15	
	3	15	
2	1	15	1
3	1	15	--
	2	15	
4	1	15	1
	2	10	
5	1	15	1
	2	5	
6	1	15	--
	2	15	
7	1	15	1
	2	15	
8	1	15	1
	2	15	
9	1	15	--
10	1	15	1
11	1	15	1
	2	15	
12	1	15	--
13	1	15	--
14	--	--	1
15	--	--	1
16	--	--	1
17	--	--	1
18	--	--	1
19	--	--	1
20	--	--	1
Total 20	22	316	14

CHAPTER VI

METHOD OF IMPLEMENTATION AND EVALUATION

In addition to developing a CMI course, this study also attempted to answer a number of questions which are related to such factors as scheduling, student performance, student attitudes, logistics, and costs. The problems investigated are listed below.

1. Scheduling

   a. How many terminals are needed to accommodate a class?

   b. How do students self-schedule their time during the quarter?

2. Student Performance

   a. Does student control of the learning situation produce results which might be considered similar to instructor control of the situation?

   b. How do students sequence the units of instruction?

   c. Which references are read, which are listed as of no value, and which as most valuable in studying for the tests?

   d. Do students choose games, groups, or individual study?

   e. How accurately do students evaluate their own work when given guidelines?

   f. How accurately do students estimate their own ability

to complete a unit as compared with actual performance?

3. Student Attitudes

a. With what attitudes do students leave the CMI course, in relation to materials, terminal presentation, and the CMI course itself?

b. How do students perceive the role of the instructor in the CMI course?

c. How often do the students interact with the instructor of the CMI course?

4. Logistics

a. Were all the necessary components for this type of course programmed using the existing 1500 CAI system?

b. What logistics problems are encountered when running a CMI course?

c. Is the evaluation data desired during the course generated when needed?

5. Cost Factors

a. What does it cost to operate a CMI course in terms of student time on the terminal and time interacting with the instructor of the course?

b. What is the cost for library materials and handouts for the course?

c. How much does it cost to run a course, in terms of cost per student hour of credit?

d. How does the CMI cost compare with conventional classroom instruction?

Population

Subjects for the study were those students who completed the course, Techniques of Programmed Instruction, Fall quarter, 1969, at the Florida State University. Ten of the students were research fellows in a CAI trainee program and 18 were EPDA music trainees. Ten students were from the Department of Educational Research, 8 from Science Education, 10 from other departments in the College of Education, and 3 from the fields of Biology (1) and Psychology (2). This is presented in Table 5.

TABLE 5

NUMBER OF STUDENTS IN EACH AREA WHO COMPLETED THE CMI COURSE

Area	N
Music Trainees	18
CAI Trainees	10
Educational Research	10
College of Education	10
Science Education	8
Biology, Psychology	3
Total	59

A total of 55 students completed the course requirements by December 8, 1969, and an additional four students completed them by January 15, 1970. The students who took the course on an audit basis were not included in this study. The 59 students were randomly assigned to one of four treatment groups, with the experimental variables involved being sequencing and product evaluation. Table 6 presents the

total number of students in each of the groups, which are described below.

TABLE 6

NUMBER OF STUDENTS IN EACH TREATMENT GROUP*

	Computer-Facilitated Evaluation	Instructor-Evaluated	Total
Self-regulated Sequence	15	15	30
Set-Sequence	14	15	29
Total	29	30	59

Design

Sequencing

The sequence of units in the CMI course was either set, i.e., the student took the units in a logical order according to the task analysis, or was self-selected by the student. Half of the class was randomly assigned to the set-sequenced treatment group and half to the self-sequenced group.

Product Evaluation

As the students proceeded through the course, they chose an area of instruction which they system analysed and documented. For those units which required a written product, evaluation was to be done either by the student himself, according to criteria which were presented via the terminal, or by the instructor who used criteria

identical to that presented on the terminal. Students were allowed to revise the product until it met criterion. Students within each of the sequencing groups were randomly assigned to either the student-evaluated or the instructor-evaluated group.

Students were registered on the computer with appropriate switches set for each group (see Appendix H). Group 1 students were able to choose the units in any order and evaluate their own products via a computer dialogue. Students in Group 2 were able to choose the unit order, but were to have their products evaluated by the instructor according to the identical criteria as they appeared on the computer for Group 1. Group 3 was presented, in the set-sequence, the units from 1 through 20, and they scored their own written products according to the criteria on the computer. Those students in Group 4 were presented the units in the set-sequence and had the products evaluated by the instructor.

Equipment

The FSU-CAI IBM 1500 Instructional System, with IBM 1510 terminals, was used to manage the course. The terminals consist of Cathode-Ray Tubes with keyboard and light pen response capability. All responses for the CMI program were keyboard coded, i.e., required a typed response from the student.

Materials

The materials used in the CMI course were either instructional or evaluational. Most of the evaluation instruments were developed specifically for the course.

The following materials, labeled "EDR 537 Handout," served as a study guide for the students. They were distributed to the students at the first class session:

1. Course Information sheet
2. Task Analysis of the course content
3. Flow Chart of the computer logic
4. Contract sheet for each unit containing:
   a. Unit description
   b. Behavioral objectives for the unit, both cognitive and productive
   c. References for the unit
5. Evaluation Criteria for the final product
6. Bibliography (Appendix O)
7. BID Rules

The following reference materials were available for the student to use during the course:

1. Copies of articles and papers
2. Books
3. Journals
4. Instructional Game, COMMENT (Hagerty, 1969)

Description of Instruments Used in the Study

The General Information Questionnaire (see Appendix J) was designed to elicit biographical data on the student and his prior experience with courses and materials related to programmed instruction.

A pretest (see Appendix D) and a midterm test (see Appendix E) were developed to evaluate the student's ability to recall the cognitive information required of the first 13 units. These tests were alternate forms.

Student Attitude Toward Computer-Managed Instruction (see Appendix K) is an adaptation of Brown's Scale (1966). This scale has been used with other groups and Brown (1966) reported a reliability of .89 for the instrument.

The Information Questionnaire (see Appendix L) was developed to elicit information on attitudes, time allotments and scheduling during the course, attitudes of the students about the course, and as a check on data generated by the CMI presentation.

The General Questionnaire Sheet (see Appendix M) was prepared as a double check on the area initially chosen by the student and the one he used to prepare his PI text, and who he used as a subject matter expert in the preparation of the text. The sheet was also used as a source for final comments by the students on any aspect of the course.

The following instruments were administered to all students during the first class period (September 29, 1969):

1. Trait Anxiety Scale*
2. General Information Questionnaire
3. Pretest for Programmed Instruction Course
4. Attitude Toward Learning Scale*
5. OPI Personality Scale*

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*See Gallagher, 1970, for description and results.

6. State Anxiety Scale*

The following instruments were administered to all students on the last day of class (December 8, 1969):

1. Student Attitude Toward Computer-Managed Instruction
2. Information Questionnaire
3. Trait Anxiety Scale*
4. Attitude Toward Learning Scale*
5. Student Assessment of Anxiety Scales*
6. Ranking of difficulty of EDR 537 Units*
7. General Questionnaire Sheet

Three folders of instructional materials were prepared for each unit which contained all references which were not available in books. These folders were available to the student on a loan basis. The student could obtain copies of the folder materials at five cents per page. Multiple copies of the reference books were purchased for inclusion in a library, along with the folders, as well as the evaluation materials. These were made available for use by the student during the course. The library also served as an office for the two assistants.

Procedures

On September 29, 1969, the first class meeting was held. As the students entered the room, they were handed the General Information Questionnaire, Trait Anxiety Scale, and the Pretest for Programmed

*See Gallagher, 1970, for description and results.

Instruction Course. When they had completed these, they were given the Handout containing the course materials. Each part of the handout was explained and the reasons for using Computer-Managed Instruction with this course were given. The Attitude Toward Learning Scale was then given to the students for completion. At the end of the class each student was given a personality scale and an anxiety scale, which were to be returned prior to beginning work at the computer terminal.

Students scheduled time on the computer terminal and received an introduction to the course during the week following the first class meeting. Throughout the remainder of the quarter, pacing was strictly up to the needs or abilities of each student. The entire CMI course was handled as an educational game according to the rules of BIL (see Appendix A). The units defined by the task analyses made up those defined on the contract sheets. BID was included as a motivational tool in that it was used to evaluate the student's assessment of his own abilities, and points earned were used in partial determination of his grade. The students were told that 20 percent of their final grade for the course would depend on the BID total, 30 percent on the midterm examination grade, and 50 percent on the grade for the final product. Also, a student must have completed all of the units in order to receive a passing grade for the course.

A list of areas which instructors felt needed PI texts was prepared and given to the students at the beginning of the course. The list served several purposes. It made the student aware of the areas in need of programmed texts, and allowed him to choose one in

line with his own background and goals. It presented the names of professors who were willing to act as subject matter experts in the development of the texts. This also meant that they would be willing to provide subjects for use in evaluating the written tests.

There were several selected topics pertinent to the area of programmed instruction, but not required as indicated by the task analysis, which students could study in order to gain extra BID points. For each designated area, such as history of programmed instruction, teaching machines, or operant conditioning theory, the student could write a one-page review and receive from one to ten extra BID points.

Activities of the students from September 30 through December 8, 1969, consisted of those events indicated by the flow chart previously presented in Figure 3. These were essentially: sign on to the program, take the test, designate the next learning unit, sign off, study and/or write, and sign on again.

The midterm examination was administered to a student when he had completed the first 13 cognitive units on the computer terminal. Students were free to contact the instructor or the assistants during office hours to discuss any problems they may have encountered in the course. A record sheet was developed in order for the instructor and the assistants to record who needed help on which topic for how lon A copy of the sheet may be found in Appendix N.

On December 8, 1969, the class met again, at which time tho students who had not already done so were to turn in their final

written product for the course. Four students failed to complete course requirements at this time, but were to have them completed by January 20, 1970. Students were given a packet of evaluation materials to complete before they were dismissed.

CHAPTER VII

RESULTS OF THE FIELD TEST

The results of using CMI in presenting a graduate course of instruction were analysed under five main headings: (1) Scheduling, (2) Student Performance, (3) Student Attitudes, (4) Logistics, and (5) Cost Factors. These will be presented in order, with pertinent questions under each heading discussed and data presented in response to those questions.

1. Scheduling

Records were maintained which listed the appointments made by the students for terminal time and the mid-term examination. Students were also asked their preferences for terminal time availability.

a. How many terminals were needed to accommodate the students in the CMI class?

Scheduling for the CMI sessions on the computer terminals began on October 6, 1969. At that time at least five terminals were available to the students from 3:30 to 5:00 p. m. on Monday, Tuesday, Wednesday, and Thursday, and from 7:30 to 10:00 p. m. on Monday nights, a total of eight and one-half hours terminal time per terminal, or 42.5 hours per week. An additional 4.5 hours was provided the 5th and 6th week on Thursday night.

When asked when they would have preferred to have the terminals available, 13 students (22%) would have preferred it in the mornings, 13 (22%) in the evenings, 11 (18%) all day, and 3 (5%) on weekends.

Terminal time was scheduled in 15-minute blocks. Use of the terminals peaked the week before the midterm examination, as presented in Table 7, then drastically declined to the end of the quarter. The schedule is only an estimate of use, since students would come to the Center without scheduling a terminal and use one if it were available. The 627 blocks of total usage shown in Table 7 indicates 156.75 hours of terminal time. Actual terminal utilization for the quarter, as indicated by the user's file (a computer-maintained time record) was 259.6 hours.

TABLE 7

TERMINAL USAGE BY WEEK FOR CMI COURSE
AS INDICATED BY SCHEDULE SHEETS

Week in Quarter		Terminals by 15-min. blocks Available	Used	% of Usage
1		150	84	56
2		150	113	75
3		150	96	64
4		150	98	65
5		168	121	72
6	Midterm	168	85	51
7		150	8	5
8		150	17	11
9		150	5	3
Total		1380	627	45

The means, medians, and standard deviations for the four treatment groups for total terminal time is presented in Table 8. The means ranged from 251.53 to 284.28 minutes. The set-sequenced computer-evaluated group utilized 32.75 minutes more time on the computer than did the self-sequenced instructor-evaluated group. The average time for the 59 students was 264.32 minutes, or 4.40 hours per quarter. Students needed more time the first seven weeks (see Table 7), which may indicate that five terminals available for 52 hours, with most of those hours in the first seven weeks, could accommodate 59 students a quarter. Broken down by week, approximately 8 hours per terminal per week would be needed or 1.6 hours per day for each terminal.

TABLE 8

MEAN, STANDARD DEVIATION, AND MEDIAN TERMINAL INTERACTION TIME ON CMI COURSE BY GROUPS AND TOTAL CLASS
(In Minutes)

Group	$\bar{X}$	S.D.	Median
Self-Sequenced Computer-Evaluated	260.26	54.11	256
Self-Sequenced Instructor-Evaluated	251.53	44.32	250
Set-Sequenced Computer-Evaluated	284.28	46.96	278
Set-Sequenced Instructor-Evaluated	262.53	39.79	264
Total Group	264.32	46.91	264

In analysing terminal time, one student's time was dropped since it was three times longer then any other student's. When the time of a randomly selected student was compared with that of the above mentioned student, he had a lower total response time per question and therefore the unaccountably high terminal time must have been due to some other factor, such as the failure to sign off at the end of a lesson.

b. How did students schedule their time during the quarter?

The schedules of two students are presented to show the extreme variation among individuals in how they spent their time. The first student went to the CMI library every day during office hours, read nearly every primary reference and had numerous discussions with the assistants. She took the tests after studying, setting no special deadlines. The second student completed the first 13 units in one week, wrote the productive units in the next two weeks, evaluated them and completed the documentation well before the other students in the class. His schedule is presented in Table 9.

Both of these students performed in the top percentage of the class, and both received A's. The remainder scheduled themselves between these two extremes, with 10 students (17%) working on two units per week, 13 (22%) working on three units per week, 12 (20%) fit it into their other work, and 9 (15%) had no plan for studying and taking the tests. There were 8 (13%) who indicated that they were paced by the course, but made no further explanation.

TABLE 9

SCHEDULE OF COMPLETION OF UNITS IN CMI COURSE BY THE FASTEST STUDENT

Date	Hours	Unit Studied	Unit Test Passed
November 8 (Saturday)	2:00	1-4	
November 10 (Monday)	2:00	5-7	
	:15		1
	1:30		2-7
November 11 (Tuesday	2:00	8-10	
	:30		8-10
November 12 (Wednesday)	2:00	11-13	
	:30		11-13
November 13 (Friday)	3:00	1-13	
	1:30		Midterm
Subtotals	8:00	1-13	
	2:45		1-13
	3:00	1-13	
	1:30		Midterm
Total	15:15		

The deadline for the midterm test was November 14. Students were to have completed the first 13 units on the computer before taking the test. Table 10 indicates when students took the test. Six (10%) completed the requirements before November 7, while 15 (25%) took the test on November 14. Five percent of the students failed to meet the deadline, but presented sufficient justification to allow them to take the test the following Monday. The test packet for the midterm averaged one hour completion time, with a range from 35 to 95 minutes.

TABLE 10

NUMBER OF STUDENTS TAKING THE MIDTERM TEST PRIOR TO AND FOLLOWING THE DEADLINE OF NOVEMBER 14, FOR CMI COURSE

Date	Number of Students	%	Cumulative %
Prior to Nov. 7	6	10	10
Nov. 7	8	14	24
Nov. 10	9	16	40
Nov. 11	5	8	48
Nov. 12	7	12	60
Nov. 13	6	10	70
Nov. 14 Deadline	15	25	95
After Nov. 14	3	5	100
Total	59	100	100

2. Student Performance

The CMI and the traditional classes were used to compare product evaluation scores between instructor- and student-controlled situations. The experimental variables, sequencing and evaluation, were used to determine their effect on student's performance on midterm, attitude, and product evaluation scores. Use of the PI texts produced by the students is also discussed.

a. Did student control of the learning situation produce results which might be considered similar to instructor control of the situation?

To answer the question whether student control of the learning situation produced results similar to instructor control, two analyses were used; the scores of the final document for each type of class and

the differences between three subgroups in the self-sequenced group. The scores of the final documents from the traditionally taught class (Fall, 1968) were compared with the scores from the CMI class. The means and standard deviations of the product scores showed a difference between means of 1.34 points on a 75 point scale and a difference in standard deviations of 4.49 units, as shown in Table 11. There was little difference between the groups.

TABLE 11

MEANS AND STANDARD DEVIATIONS FOR TWO CLASSES ON FINAL PRODUCT SCORES

Class	n	$\bar{X}$	S.D.
Traditional (1968)	38	50.66	13.21
CMI (1969)	59	49.32	8.72

The means and standard deviations for the self-sequenced group of 30 students indicated that they received the highest scores on the midterm and the final product, had the highest points on the attitude questionnaire, and took less time to complete the course than did the set-sequenced group, as presented in Table 12. The self-sequenced instructor-evaluated group had the highest pretest scores while the self-sequenced computer-evaluated group had the lowest pretest scores. The possible and obtained range of scores for the five variables are also presented in Table 12.

TABLE 12

MEANS AND STANDARD DEVIATIONS FOR EACH TREATMENT GROUP ON FIVE VARIABLES AND POSSIBLE AND OBTAINED RANGE OF SCORES FOR CMI COURSE

Group	Pretest		Midterm		Final Product		Terminal Time		Attitude	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Self-Sequenced Computer-Evaluated	9.67	8.00	95.80*	4.46	50.53*	9.75	260.27	54.11	143.80+	19.37
Self-Sequenced Instructor-Evaluated	16.27*	16.21	95.27+	5.53	51.53+	7.00	251.53	44.32	145.87*	11.08
Set-Sequenced Computer-Evaluated	13.21	10.91	92.14	9.15	46.07	9.79	284.28*	46.96	143.36	13.61
Set-Sequenced Instructor-Evaluated	14.87+	12.32	94.73	4.33	48.93	8.04	262.53+	39.79	135.13	13.77
Possible range of scores	1-100		1-103		1-75		1-1380		40-200	
Obtained range of scores	1-25		76-102		32-66		169-387		95-172	

*indicates the highest mean for the variable.
+indicates the 2nd highest mean for the variable.

The products written by the students, i.e., the PI texts, were filed each year for use by future classes. Those written by the traditional class were not used beyond this, except for one which was used as a supplement to another course. The texts produced in the CMI class were also filed for future use, but students indicated that 55 (93%) of them would be used in other courses either by the student himself or by the professor who served as subject matter expert.

b. How did students sequence the units of instruction?

The students in the self-sequenced group chose the course units in a variety of sequences as presented in Table 13. Thirteen (22%) of the students followed the numerical sequence, 11 (18%) deviated from that sequence more than three times, and one student reordered all 13 units. Six students (10%) reordered three units or less.

Midterm scores, final product scores and attitude scores were analysed for the self-sequenced groups for: (1) those students who changed the sequence three times or less, (2) those who changed it more than three times, and (3) those who made no changes in the sequence. The means and standard deviations, as presented in Table 14, indicate that those who made more than 3 changes in the sequence obtained higher scores on the midterm, and had higher attitude scores. Those who made no changes had the highest final product scores.

TABLE 13

SEQUENCE CHOSEN BY SUBGROUPS IN SELF-SEQUENCED GROUP IN CMI COURSE (N = 30)

N	Sequence												
	1	2	3	4	5	6	7	8	9	10	11	12	13
More than three changes													
1	1	2	3	6	9	13	12	4	5	7	8	10	11
1	1	2	3	6	7	5	4	8	9	10	11	12	13
1	1	3	12	6	9	13	2	7	4	8	10	11	5
1*	3	1	2	6	4	5	7	8	9	10	12	13	11
1	3	6	9	1	2	4	5	13	12	7	8	10	11
1	1	3	6	9	12	2	13	4	5	7	8	10	11
1	1	3	2	6	9	10	4	5	7	8	11	12	13
1	1	3	2	4	5	7	8	6	9	10	11	12	13
1	1	3	2	6	4	5	7	8	9	10	11	12	13
1	1	2	3	4	7	11	8	5	13	6	9	10	12
1	1	3	13	2	7	11	4	5	8	12	6	9	10
Three changes or less													
1	1	2	3	4	5	6	7	8	9	10	12	11	13
1	1	2	3	4	5	6	7	8	9	10	11	13	12
1	1	2	3	4	5	7	6	8	9	10	11	12	13
1	1	2	3	6	5	4	7	8	9	10	11	12	13
1	1	3	2	4	5	6	7	8	9	10	11	12	13
1	2	1	3	4	5	6	7	8	9	10	11	12	13
No changes													
13	1	2	3	4	5	6	7	8	9	10	11	12	13

*This student chose Unit 3 first, then Unit 1, Unit 2, Unit 6, and so on.

TABLE 14

MEANS AND STANDARD DEVIATIONS FOR THREE SUBGROUPS WITHIN THE SELF-SEQUENCED GROUP ON THREE VARIABLES (N = 30)

Group	Number of reordered units	N	Attitude		Midterm		Final Product	
			$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
1	< 3	6	148.50*	10.25	96.67*	4.76	52.33+	5.01
2	> 3	11	146.91+	11.45	95.81+	4.53	47.54	9.74
3	none	13	141.38	20.17	94.77	5.58	53.38*	7.83

*indicates highest score for the variable.
+indicates 2nd highest score for the variable.

c. Which references were read, which were listed as of no value and which as of most value in studying for the tests?

Prior to each unit test, students identified the references they studied as of most value or of no value. This information, to be used in revising the resources for the course, is presented in Table 15. Groups showed fairly consistant responses in what they read and what they found most valuable. Total responses for each unit are presented, rather than by group, for ease of interpretation.

When a student failed a test, his reference selection on second attempt was identified as second pass. On this pass the information presented by the student was highly consistent with that of the first pass. Percentages under first pass total are for 59 students, while those under most value and no value, in Table 15, are for the percent of total group who indicated having studied that reference. For example, under Unit 1, "DeCecco (1968) (see Appendix O)," was studied by 93% of the group, while of the 93%, 5% felt it was of no value in studying for the test and 12% felt it was of most value. On second pass, 90% of those students who failed the test studied the reference, and of that 90%, 5% felt it was of most value.

On first pass information, references studied by less than 10 percent of the students were dropped from the analysis. In seven cases, students listed references for a unit other than the one for which it was recommended. Where students in the 10% group indicated whether the reference was of no value or most value, 65% were in the no value category. This category indicated that the references were of no value in studying for the test.

TABLE 15

PERCENTAGE OF 59 STUDENTS WHO STUDIED A REFERENCE, AND PERCENTAGE OF THOSE WHO STUDIED IT AND INDICATED IT WAS OF MOST VALUE OR OF NO VALUE IN PREPARING FOR THE TEST ON FIRST AND SECOND PASS

Reference Studied*	1st Pass Percent			2nd Pass Percent		
	Total	No Value	Most Value	Total	No Value	Most Value
UNIT 1						
DeCecco (1968)	93+	5#	12	90	--	5
Taber, Glaser & Schaefer (1965)	92	4	25	91	--	28
Alexander & Yelon (1969)	90	31	7	68	53	--
Hansen & Dick (1969)	95	16	67	100	8	71
Silvern (1968)	18	36	9	9	--	--
UNIT 2						
Espich & Williams (1969)	97	3	41	91	--	54
Lysaught & Williams (1963)	93	4	71	83	--	50
UNIT 3						
Lysaught & Williams (1963)	92	5	42	89	--	42
Glossary (nd)	93	--	46	85	8	39
Mathis (1964)	90	9	24	89	12	25
Morgan & Branson (1964)	13	--	12	11	--	--
UNIT 4						
Gagné & Paradise (1961)	92	11	43	100	12	17
Gagné (1962)	92	4	36	100	12	12
Gagné (1968)	88	6	26	100	8	25
Okey (nd)	38	--	43	50	--	50
UNIT 5						
DeCecco (1968)	98	--	76	91	--	75
Fry (1963)	95	19	14	82	22	22
Lysaught & Williams (1963)	18	9	9	8	--	--

*Bibliography in Appendix O.

+Percentage of 59 students who studied this reference.

#Percentage of Total who indicated this reference was of no value in studying for the Unit 1 test.

TABLE 15.--Continued

Reference Studied	1st Pass Percent			2nd Pass Percent		
	Total	No Value	Most Value	Total	No Value	Most Value
UNIT 6						
Espich & Williams (1969)	98	--	89	100	4	70
Lysaught & Williams (1963)	13	--	12	6	--	--
Markle (1964)	70	19	2	59	19	13
UNIT 7						
Mager (1962)	98	--	85	93	--	78
Lipe (nd)	73	9	11	21	--	--
UNIT 8						
DeCecco (1968)	85	2	61	100	--	67
Esbensen (1968)	77	6	21	93	--	27
Gagné (1965)	80	12	39	100	20	47
UNIT 9						
Espich & Williams (1969)	98	--	43	100	11	17
Glaser (1965)	78	23	19	72	8	39
Lysaught & Williams (1963)	95	--	52	100	11	44
UNIT 10						
Espich & Williams (1969)	97	--	47	100	--	44
Glaser (1965)	80	2	25	81	--	46
Lysaught & Williams (1963)	95	2	44	100	--	63
UNIT 11						
Thorndike & Hagen (1961)	72	--	67	100	--	80
Burns (1968)	68	10	7	67	30	20
UNIT 12						
Espich & Williams (1969)	83	--	62	100	--	57
Glaser (1965)	27	31	12	43	--	9
Lysaught & Williams (1963)	50	7	17	43	--	67
Tyler, Gagné & Scriven (1967)	20	25	8	43	--	--
Rosenoff (nd)	60	22	14	100	--	43

TABLE 15.--Continued

Reference Studied	1st Pass Percent			2nd Pass Percent		
	Total	No Value	Most Value	Total	No Value	Most Value
UNIT 13						
Fry (1963)	72	16	30	89	37	12
Briggs (1967)	70	2	35	100	33	22
UNIT 14						
Espich & Williams (1969)	78	--	74	--	--	--
UNIT 15						
Espich & Williams (1969)	75	--	78	--	--	--
Lysaught & Williams (1963)	58	--	23	--	--	--
UNIT 16						
Espich & Williams (1969)	77	--	76	--	--	--
Lysaught & Williams (1963)	58	--	75	--	--	--
Recommendations (1966)	18	9	18	--	--	--
UNIT 17						
Espich & Williams (1969)	70	--	76	--	--	--
Lysaught & Williams (1963)	50	--	37	--	--	--
UNIT 18						
Recommendations (1966)	63	--	68	--	--	--
UNIT 19						
Recommendations (1966)	52	--	61	--	--	--

The students ordered a total of 48 copies of articles and papers. Of those 48, 37% were for the Glossary of PI Terms. The remainder of requests were for references from the entire range of suggested resources.

d. Did students choose games, groups or individual study?

Students did not sign up for small group discussions, even though they were encouraged to do so. However, by talking to them it became apparent that they informally met as discussant groups. Also, many group discussions began around the CAI terminals and in the library as an outgrowth of questions directed to the assistants.

Indications on the Information Questionnaire showed that 13 students (22%) wanted optional group discussions scheduled, while 25 (42%) wanted from one to all classes held, as scheduled by the registrar. There were 31 students (52%) who felt that the class should not meet at all. In line with this, 37 students (62%) would not have preferred "text and lecture classes," 18 (30%) indicated that "maybe" they would prefer them, and 4 (7%) stated that they preferred text and lecture classes absolutely for this course.

Three students played the game COMMENT. Their response to it was favorable and they felt they learned about the use of taxonomies and teacher-questioning of students. One student asked if playing the game would in any way influence the grade she got for the course. When told it would not, she stated that she would like to play it, but just did not have the time. Another student could not find two others with enough time to play the game. For the most part, the game was ignored.

e. How accurately did the student evaluate his own work when given criteria guidelines?

It was difficult to analyse the data for this question since only two students in the computer-facilitated evaluation group failed to pass all productive units. On the criterion questions there were only three incorrect responses indicated for specific questions, while all other responses indicated correct or adequate products. All students evaluated by the assistants passed the criteria questions on all units. Some students enlisted the aid of the assistants before product evaluation in order to have the product corrected before the formal evaluation.

f. How accurately did students estimate their own ability to complete a unit as compared with actual performance?

Students bid on the first 13 units on their estimate of their own performance. Mean bids for the first, second, third, and so forth, unit chosen (not necessarily Unit 1, Unit 2, and so forth) are presented in Table 16. Mean second bids, after a failure on the first bid, were higher on all but two choices. A further breakdown is presented in Table 17, which shows bids of 10 and <10, and pass or fail, on first, second and third bid.

There were 59 students and 13 units, or 767 total possible bids for the class. Of that total, 453 of the first bids were for 10 points and were passed, and 140 were for 10 points and were failed. These figures represent respectively, 77% and 23% of total first 10 point bids and 59% and 18% of total first bids. Fifty-nine percent of the units on first bid and 78% on second bid were passed.

TABLE 16

MEANS ON FIRST AND SECOND BIDS IN RELATION TO ORDER IN WHICH UNITS WERE CHOSEN
(Maximum Bid = 10)

Unit Chosen	First Bid $\bar{X}$	Second Bid $\bar{X}$
1st	8.79	8.81
2nd	9.52	9.38
3rd	9.14	9.65
4th	8.98	9.33
5th	8.98	9.73
6th	8.88	9.64
7th	9.39	10.00
8th	8.41	9.90
9th	8.85	9.68
10th	9.25	9.53
11th	8.71	9.73
12th	9.41	9.28
13th	8.81	10.00

An examination of Table 17 shows that students who bid less than 10 points failed more often than students who bid 10, on either first or second bid. On all three bids, students tended to bid 10 points for a unit more often than a lesser amount.

Students' responses to the Information Questionnaire in relation to the BID game were categorized and are presented in Table 18. Twelve students (20%) stated that BID was a motivational device, while the other students made comments which ranged from, "Made it interesting," to, "Ugh." A student who consistently bid less than 10 points made the remark, "I do not like the idea of bidding since I always have a tendency to be conservative. I would worry about the loss of 10 points."

TABLE 17

STUDENT BIDS OF 10 POINTS OR LESS THAN 10 POINTS, PASS OR FAIL STATUS, ON FIRST BID, SECOND BID, AND BIDS AFTER TWO FAILURES

Bid	Status	Group 1	2	3	4	Sub-Total	% of Sub-Total	% of Total
1st Bid of 10	PASS	118	116	105	114	453	77	59
	FAIL	41	37	31	31	140	23	18
Subtotal		159	153	136	145	593	100	
1st Bid of <10	PASS	17	25	23	24	89	51	12
	FAIL	19	17	23	26	85	49	11
Subtotal		36	42	46	50	174	100	
Total		195	195	182	195	767		100
2nd Bid of 10	PASS	46	48	40	41	175	89	78
	FAIL	9	4	6	3	22	11	10
Subtotal		55	52	46	44	197	100	
2nd Bid of <10	PASS	4	2	5	10	21	75	9
	FAIL	1	--	3	3	7	25	3
Subtotal		5	2	8	13	28	100	
Total		60	54	54	57	225		100
3rd Bid of 10		9	4	7	3	23		79
3rd Bid of <10		1	--	2	3	6		21
Total		10	4	9	6	29		100

TABLE 18

COMMENTS BY CATEGORY ON BID AS USED IN THE CMI COURSE

Category	Number of Students	%
Fun, enjoyable	7	12
Motivating	12	20
Initially difficult	7	12
Okay	10	17
Not needed	6	10
Did not like it	7	12
Discouraging	6	10
Ugh! Absurd! etc.	4	7
Total	59	100

3. Student Attitudes

Data generated by the attitude questionnaire and the information questionnaire were used in answering the following questions concerning students' attitudes following completion of the CMI course.

a. With what attitudes did students leave the CMI course, in relation to materials, terminal presentation, and the CMI course itself?

At the end of the CMI course, when asked if they would take another CMI course, 33 (55%) of the students responded "Gladly," 22 (37%) "Possibly," and 2 (4%) each for "Reluctantly" and "Never." This is presented in Table 19.

When asked if they felt that the course material was more relevant to their professional goals than that of other courses, as presented in Table 20, 24 students (40%) felt it was, 34 (57%) felt it was as relevant as others, while 1 (2%) felt it was less so.

When asked if they felt that the course asked for "too much work," 25 (42%) indicated they had "way too much," and 30 (50%) that they had "more than most" courses. This is presented in Table 21.

Students were asked if the criteria questions for the product evaluation were relevant and adequate. The results are presented in Table 22. Forty students (67%) indicated that most questions were relevant, 8 (14%) that they were extremely relevant, and 9 (15%) that some were relevant. Forty-one (68%) felt that most of the questions were adequate, 10 (17%) that some were adequate, and 5 (9%) that they were extremely adequate.

TABLE 19

RESPONSES TO "WOULD YOU TAKE ANOTHER COURSE BY COMPUTER-MANAGED INSTRUCTION?"

Category	N	%
Gladly	33	55
Possibly	22	37
Reluctantly	2	4
Never	2	4
Total	59	100

TABLE 20

RESPONSES TO "DO YOU FEEL THE MATERIAL IN THIS COURSE WAS RELEVANT TO YOUR PROFESSIONAL GOALS?"

Category	N	%
More relevant than other courses	24	40
As relevant as other courses	34	58
Less relevant	1	2
Not at all relevant to my goals	--	--
Total	59	100

TABLE 21

RESPONSES TO "DID YOU FEEL YOU HAD TOO MUCH WORK TO DO IN THIS COURSE?"

Category	N	%
Way too much	25	42
More than most courses, but not too much	30	50
Same as most courses	2	4
Less than most courses	1	2
Not enough work	1	2
Total	59	100

TABLE 22

RELEVANCE AND ADEQUACY OF PRODUCT CRITERIA QUESTIONS FOR 59 STUDENTS IN CMI COURSE

Relevant	%	Adequate	%
Extremely relevant	14	Extremely adequate	9
Most were relevant	67	Most were adequate	68
Some were relevant	15	Some were adequate	17
Lacked some relevance	4	Lacked some adequacy	2
Extremely irrelevant	0	Extremely inadequate	4
Total	100		100

Attitudes toward the course were assessed using "Attitude Toward Computer-Managed Instruction," a modified form of Brown's Scale (1966). The reliability of the scale was .88 for the CMI class. This K-R_{20} reliability nearly replicates the .89 found by the author (1966). Out of a total possible score of 200, the class ranged from 95 to 172. The summary table of the attitude date is presented in Table 23. Among the groups, the set-sequenced instructor-evaluated group had the lowest mean (135) and the self-sequenced instructor-evaluated group had the highest (146).

TABLE 23

MEAN, STANDARD DEVIATION, AND MEDIAN SCORES ON STUDENT ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION BY GROUPS AND TOTAL CLASS

Group	$\bar{X}$	S.D.	Median
Self-Sequenced Computer-Evaluated	143.80	19.37	143
Self-Sequenced Instructor-Evaluated	145.87*	11.08	144
Set-Sequenced Computer-Evaluated	143.36	13.61	145
Set-Sequenced Instructor-Evaluated	135.13	13.77	135
Total Group	142.02	14.99	144

*High score favorable to CMI.

Students were asked to comment on the course, making any statements they felt were pertinent. Table 24 presents a representative sample of the statements made by the students, and indicates in parenthesis the number of students who made similar comments.

TABLE 24

RESPONSES TO THE STATEMENT: "WE WANT AN HONEST STATEMENT ON ANYTHING YOU FEEL IS PERTINENT TO THE CLASS."

Responses
"I enjoyed taking a course which had been so carefully planned. It was rather a shocking blow the first week learning how much work was involved but once the logic of what we were asked to do became apparent it was appreciated." (9)
"I felt the course was most relevant. I had never been exposed to the 'latest happenings' in education. I now see many areas of application to my own field of interests." (6)
"This has been an exceptional experience. I wish you could get to people in the Biology Department and help them develop such programs. I would like to take other such courses." (2)
"This course entails enough work to be worth 5 graduate hours.* Otherwise Beautiful, recommend it to all graduate students." (11)
"Much of the reading material was not relevant with the questions asked. The reading should be shortened. . . Very good course." (8)
"The work load was too much for the hours credit. The anxiety tests were unclear. Some test questions were unclear. The references should be completely revised, clarified, and programmed." (4)
"No real gripes about CMI. Better than listening to a prof drone on." (2)
"Great course! The only bad times were when the terminals moved slowly due to heavy use. Also, the tasks 14-20 should not all be put on the terminal for not computer evaluated people." (4)

*Course was offered for 3 credit hours.

The general feeling was that the course was helpful, well planned, and too much work for the credit received. During the course students commented that they were spending too much time on this course and not enough on their other courses. When asked why, the usual answer was that they enjoyed it more and felt they were learning more.

b. How did students perceive the role of the instructor of the CMI course?

The role of the professor of the course was non-existent as far as 35 (58%) of the students were concerned. For 18 students (30%) the professor's role was as counselor and guidance person, while 6 (10%) felt his role was as evaluation expert, and 5 (8%) went to him for help as a source expert. Table 25 shows the role of the instructor as perceived by the students in the CMI course, as well as the perceived role of the student assistants. Forty-seven students (78%) viewed the student assistants as both source experts and guidance and counseling experts, while 18 (30%) saw them as evaluation experts.

TABLE 25

ROLE OF THE PROFESSOR AND ASSISTANTS FOR CMI COURSE

Interaction Role	% Interacted with	
	Professor	Assistants
Source expert	8	78
Counseling and Guidance	30	78
Group leader	0	10
Evaluation expert	10	30
Not at all	58	2

c. How often did the students interact with the instructor of the CMI course?

During the course the professor met with 13 students (22%) in his office, none more than once, for from 7 to 30 minutes, for a total of 3 hours and 21 minutes. The students went to the assistants and fellow students for help much more than they went to the professor, as shown in Table 26.

TABLE 26

TOTAL INTERACTIONS PER STUDENT WITH THE PROFESSOR, ASSISTANTS, AND FELLOW STUDENTS DURING THE 10 WEEK COURSE

Frequency	Number of Students Who Interacted With		
	Professor	Assistants	Fellow Students
0	34	1	9
1	15	3	0
2	4	3	6
3	2	1	5
4	4	1	2
5	--	5	4
6	--	7	2
7	--	2	--
8	--	2	--
9 - 15	--	21	10
Many	--	13	21

4. Logistics

Development of the logic for CMI was accomplished in line with the requirements of the FSU CAI Instructional system and the components desired for the CMI course. Questions relating to the similarity of demands of both the requirements and the components are answered next.

a. Were all the necessary components for this type of course (CMI) programmable using the existing 1500 CAI system?

Implementing the tests on the computer with random selection of items presented no special problems, nor did developing the logic for providing remedial information. Diagnosis of weaknesses was done in terms of errors per objective for each unit. Recordkeeping consisted of recording the units chosen or assigned, and counting errors made on those units, as well as how many times a student failed a unit. Comments and miscellaneous data generation aspects required no special adjustments to the system.

b. What logistics problems were encountered when the course was in operation?

Development of the CMI course logic was complete and accurate as far as management of the course was concerned. However, a special computer program (a Coursewriter II function) failed to perform properly and 14 students were branched back to the beginning of tests on which they were working.

Several problems in relation to the terminal presentation caused some difficulty to the students.

1. A few correct answers to questions were incorrectly coded

as wrong. These were corrected before more than five students had proceeded through the units involved.

2. Students typed in answers, but failed to indicate when they were through typing (execute the enter function) until the proctor indicated the failure and showed them the correct method. This occurred primarily early in the course and had no effect other than to lengthen the response time.

3. Students felt that the reference questions should be presented after the test, as they did not think they knew which references were of value unless they had taken the test. The investigator retained the original sequence since it was felt that a student who failed a test would be a better judge on the second pass as to which references were of the most value in studying for the test.

4. The message frame proved inadequate for the initial problems encountered by students, since they required more information than was practical for the frame co ,andle. A "Special Message Memo" was generated for this purpose.

c. Were the evaluation data desired during the course operation generated when needed?

The investigator requested that the comments typed by the students be printed out for evaluation every weekend the course was in operation, but due to backlogs, these data were not generated, nor were any other data made available for analysis until completion of the course by all of the students. A detailed listing of all responses was provided at the end of the course which provided all the information desired for evaluation of the program.

5. Cost Factors

The costs incurred in the operation of the CMI course for one quarter, with 59 students, was determined and are presented below.

a. What did it cost to operate the CMI course in terms of time on the terminal and time interacting with the instructor?

Students averaged 4.40 hours terminal time during the quarter. Charges per CAI terminal hour at the FSU CAI Center are $3.33. This figure is based on 1968 monthly cost of equipment ($17,217.00) divided by utilization per month (250 hours), divided by 31 terminals, plus 50% for systems preparation, scheduling, and non-utilization. Therefore, total cost for 59 students' interaction with a terminal for the quarter was $864.46. Expenditures for the CMI course are presented in Table 27.

Office hours for the instructors during the course were in excess of 480 hours, with 40 hours spent by the professor and at least 440 by the two assistants. Costs for the assistants, at $4.00 per hour, came to $1,760.00. A time-and-topic discussion record was started by the assistants (see Appendix N), but proved impossible to continue. A discussion would start by one student asking a question, several other students would get involved and it proved difficult to keep track of times, names, and topics covered. Thus, individual time records of student-assistant interaction did not materialize as a product of the study. However, the professor was able to keep a nearly accurate record of instructor-student interaction. Actual time interacting with students was 3 hours and 21 minutes. Instructor time spent

TABLE 27

DEVELOPMENTAL AND OPERATIONAL EXPENDITURES FOR CMI COURSE

Category	Expenditures
I. Developmental Costs	
Development of CMI Course Materials and Logic	$ 1,400.00
CAI Coding and Entering of Materials on the Computer	7,817.40
Secretarial Staff	80.00
Total Developmental Costs	$ 9,297.40
II. Operational Costs	
A. Library Costs	
Books	$ 264.40
Reproducing Materials	80.00
Subtotal	$ 344.40
B. Instruction Costs	
Publication of Handout	$ 150.00
Student Assistants	1,760.00
Professor (1/10 time)	450.00
Subtotal	$ 2,360.00
C. Computer Costs	$ 864.46
Total Operational Costs	$ 3,568.86
TOTAL PROJECT COSTS	$ 12,866.26

evaluating the final products was approximately 30 hours. Total instructor time spent on the course was determined at one-tenth time, or entailed a cost of $450.00.

b. What did the library materials and handouts for the CMI course cost?

Library costs for books needed by students in the CMI course are shown in Table 28. Those books indicated as of no value or which were not read are deleted; only those books indicated as of most value in studying for unit tests are included in the last column.

Costs for reproducing three copies of all primary and secondary articles and papers was approximately $80.00. Total library materials cost was $344.40. Publication expenses for the study guide for the course, which was given to the students, was $150.00.

c. How much did it cost to operate the CMI course in terms of cost per student hour of credit?

Table 28 presents total costs incurred in the development and operation of the CMI course. Total operational costs for the CMI course were $3,568.86, or $20.16 per student hour of credit for the 3 credit hour course, with 59 students enrolled. For 5 credit hours, which has been approved, the cost per student hour of credit would drop to $12.10.

d. How did the CMI costs compare with the conventional classroom instructional costs?

Comparative costs of teaching 59 students by the traditional method would have been equal to 180 graduate quarter hours, or the equivalent of 1.4 professorial positions at $4,500.00 per quarter,

TABLE 28

LIBRARY COSTS FOR BOOKS REQUIRED OF CMI COURSE, AND THOSE BOOKS INDICATED AS OF MOST VALUE FOR THE COURSE

	Book	No.	Cost/ book	Total	Cost of Books of Most Value
1.	Espich & Williams (1969)	9	3.00	27.00	27.00
5.	DeCecco (1968)	2	6.95	13.90	13.90
15.	Esbensen (1968)	3	2.75	8.25	8.25
20.	Fry (1963)	1	6.95	6.95	6.95
23.	Gagné (1965)	2	5.95	11.90	11.90
30.	Glaser (1965)	5	11.50	67.50	67.50
35.	Green (1962)	2	6.95	13.90	---
55.	Lindvall (1964)	3	1.95	5.85	---
65.	Lysaught & Williams (1963)	3	4.95	14.85	14.85
70.	Mager (1962)	3	1.75	5.25	5.25
75.	Markle (1964)	10	5.95	59.50	59.50
85.	Smith & Moore (1966)	3	2.95	8.85	---
100.	Taber, Glaser, & Schaefer (1965)	1	6.95	6.95	6.95
105.	Thorndike & Hagen (1961)	1	7.75	7.75	7.75
110.	Tyler, Gagné, & Scriven (1967)	3	[illegible]	6.00	---
	Total		78.30	264.40	229.80

which equals $6,300.00. The course has been approved as a 5 hour course. Therefore the students (59) would produce 295 quarter hours or the equivalent of 2.3 professors. At $4.500.00 per quarter, this is equal to a cost of $10,350.00 to teach the PI course in the conventional class-lecture m de. To these estimates must be added the costs of graduate assistants. Thus the CMI course would conservatively cost from one-half to one-third the cost of conventional graduate instruction.

Evaluation Instruments

Statistical analyses were performed on the CMI course evaluation data to determine the reliability of the midterm and the computer-presented questions and the correlation between questions on these two instruments. The data on these analyses are presented for informational purposes only since the statistical assumptions could not be met in all cases, i.e., the normality of the distributions and linear relationship between sets of data, due to the use of criterion-referenced tests and the resulting highly skewed distributions.

For purposes of analysis, test items for each objective were assumed to be equal in difficulty and valid in terms of how well they measured that objective. The questions were stratified by unit on first pass. The first questions presented for Unit 1, for each student, were recorded as a pass (1) or fail (0). The second question through the fifteenth question were also recorded. Likewise, the first question on Unit 2 was recorded, through the last question on Unit 13. The data thus obtained produced a stratified matrix of scores for the total class in terms of items by units and did not

represent particular questions. The first question received was not necessarily question 1, for example, due to the random generation of them.

The K-R_{20} reliability of the total items, in terms of first item received through last item received, by unit, was .777. This is presented in Table 29.

TABLE 29

ANALYSIS OF VARIANCE SUMMARY TABLE OF RELIABILITY BY STRATA FOR COMPUTER PRESENTED QUESTIONS ON FIRST PASS, IN ORDER RECEIVED

Source	df	SS	MS
Subjects	58	32.99	.5688
Strata	12	5.38	
It/Strat	97	25.20	
S X S	696	129.91	.1866
Residual	5626	712.80	.1267
Total	6489		

Reliability Estimate

R = 1 - (.127/ .569) = .777

Total questions correct for behavioral objective 1, Unit 1, were recorded as a single score, then behavioral objective 2, and so forth through behavioral objective 1, Unit 13, for each student. This produced a stratified matrix of scores for the total class in terms of behavioral objective scores by unit. The stratified K-R_{20} reliability for correct responses per objective was .622, and is presented in Table 30.

TABLE 30

ANALYSIS OF VARIANCE SUMMARY TABLE OF RELIABILITY BY STRATA FOR SCORES ON BEHAVIORAL OBJECTIVES IN SEQUENCE

Source	df	SS	MS
Subjects	58	103.43	1.7834
Strata	12	26.27	
It/Strat	9	62.45	
S X S	696	570.25	.8193
Residual	522	352.21	.6747
Total	1297		

Reliability Estimate

R = 1 - (.675/ 1.783) = .622 Strata Fixed

Test questions on the midterm were scored on a range of points dependent on the accuracy of the answer by the student. Two judges scored the tests, and where discrepancies were found, discussed the questions and arrived at a mutually agreeable score. These scores were stratified by unit, so that questions 1, 2, and 3 were added to obtain a score for Unit 1, question 4 gave a score for Unit 2, and so forth. This resulted in a stratified matrix which, when analysed, produced a K-R_{20} reliability of .593, as presented in Table 31.

A correlation was run between scores received for each unit test and points received on matching midterm questions, by student, to determine if there was a relationship between the computer presented true-false and miltiple-choice questions and the midterm completion

questions. The correlations between seven of the matching items were negative, between -.0026 and -.2086. The five positive correlations were between .0200 and .2614. These correlations are presented in Table 32.

It must be noted, however, that because the distribution of scores for the correlations were not linear, this possibly represents deflated correlation coefficients.

TABLE 31

ANALYSIS OF VARIANCE SUMMARY TABLE OF RELIABILITY BY STRATA ON MIDTERM SCORES

Source	df	SS	MS
Subjects	58	120.54	2.0783
Strata	11	1660.57	
It/Strat	5	1635.77	
S X S	638	913.79	1.4323
Residual	290	245.40	.8462
Total	1002		

Reliability Estimate

R = 1 - (.846/ 2.078) = .593 Strata Fixed

TABLE 32

CORRELATIONS BETWEEN SCORES RECEIVED ON UNIT TESTS AND ON RELATED MIDTERM QUESTIONS

Midterm Question	1,2,3	4	5,6	7	8	9	10	11	12,13	14,15	16	17
Unit Test	1	2	3	4	5	6	7	8	9,10	11	12	13
r	-.0760	-.0416	-.1842	.0318	-.0026	-.2086	-.0655	.1299	.2321	.2614	-.1353	.0200

Note: Correlations above .231 ($p < .10$).

CHAPTER VIII

DISCUSSION

This chapter contains a discussion of the problems investigated concerning the implementation and operation of a CMI course of instruction. These are summarized, with a brief statement on unusual findings and interpretations of those findings.

Development

Development of the CMI materials and logic covered a time period of seven months, and involved 350 man-hours of work. Costs for this part of the developmental phase came to $1,400.00. The computer implementation phase required a total of 505 hours of work, for a cost of $7,797.00. This CMI course was developed and implemented for less than $10,000.00.

Operation

1. Scheduling

a. How many terminals were needed to accommodate the class?

Given that a student required from 169 to 387 minutes, or an averabe of 4.4 hours terminal interaction time, a CMI course with 59 students needed five terminals available for 52 hours each during the quarter, or approximately 1.6 hours per day for each terminal.

b. How did students schedule their time during the quarter?

Thirty-nine percent of the students had a schedule for completing the work during the course, while 61 percent did not. One student completed the first 13 units in one week, taking 15 hours and 15 minutes for both study time and computer time.

2. Student Performance

a. Did students' control of the learning situation produce results which might be considered similar to instructor control of the situation?

The final product scores for the conventionally taught class (instructor controlled) and for the CMI class (student controlled) show highly similar means for the two groups. When the CMI treatment groups were compared in terms of degree of student control, it was found that students who were in greater control of their learning schedules performed slightly better than those students whose sequence was controlled by the computer.

b. How did students sequence the units of instruction?

When the self-sequenced group was given the choice of sequence for the units, 13 performed the units in the sequence indicated by the task analysis and used by the set-sequenced group. The 17 students who changed the sequence presented no consistent choice pattern; they chose 17 different sequences.

c. Which references were read, which were listed as of no value, and which of most value in studying for the unit tests?

Those references which students studied were consistently listed as primary resources and were also rated most valuable in studying for the unit tests. The references listed as of no value

can be dropped from the primary reference list and retained as a secondary source, since they could provide useful information though tangential to those specified in the behavioral objectives.

d. Did students choose games, groups or individual study?

Students chose to study on an individual basis, forming informal discussion groups when needed. The one game developed for use in the course was used by only 3 students. The lack of time and lack of pertinence to the course were given as the main reasons for not asking for group meetings or playing the game.

e. How accurately did the student evaluate his own work when given criteria guidelines, as evidenced by the score he received on the final product?

It was difficult to answer this question since only two instances of failure were noted in the computer-evaluated group, and none in the instructor-evaluated group. Differences in the final product score may be due to inaccurate assessment on the products, but this cannot be determined from the data.

f. How accurately did students estimate their own ability to complete a unit as compared with their actual performance?

Students appeared to be able to predict their performance on a unit by using the game, BID, as a tool. Students who lacked confidence in themselves about a unit test failed more often than those students who had confidence enough to bid 10 points.

3. Student Attitudes

a. With what attitudes did students leave the CMI course, in relation to materials, terminal presentation and the course itself?

Attitudes in the class toward CMI were consistantly favorable.

The students appreciated the freedom to allocate their learning and testing time and felt that the instructor should be available to help with problems related to the course. The PI texts that they produced were seen as a valuable product and were relevant to current needs of of various courses in the university.

b. How did students perceive the role of the professor and the student assistants in this CMI course?

The role of the professor and the student assistants was predominately that of source expert and guidance-and-counseling expert. Of secondary importance was the role of group leader or lecturer. Evaluation of the products by the students themselves on the computer restricted the role of evaluation expert for the professor and assistants, but retained it for them in relation to the final product evaluation.

c. How did students interact with the student assistants and the professor of the course?

Students interacted with the assistants and fellow students a greater number of times than they did with the professor. Since the assistant's role was similar to that of the professor, this does not mean that the students did not interact with the instructor of the course, since both professor and assistants were instructors. It does mean that students sought the help of fellow students to a great extent, drawing on their knowledge, and on the aid of the assistants, rather than that of the course professor.

4. Logistics

a. Were all the necessary components for this type of course (CMI) programmable using the existing 1500 CAI system?

The components, i.e., testing, diagnosis, remedial information presentation, and recordkeeping, were all implemented as part of the existing IBM 1500 Instructional System at FSU, using the Coursewriter II programming language.

b. What logistics problems were encountered when running the course?

The failure of one Coursewriter II function was the only logistics problem encountered during the operation of the course. The logic developed for this type of CMI system was complete and accurate as planned.

c. Was the desired evaluation data generated when needed?

CAI Center backlogs in processing other data analyses requests delayed presentation of the data for the CMI course until the end of the quarter. Immediate and easily accessible records were not available from this CMI system to the instructor.

5. Cost Factors

a. What did it cost to operate the CMI course in terms of time on the terminal and time interacting with the instructor?

The cost of operating the CMI course for one quarter, with 59 students, using one professor and two graduate assistants, came to $3,224.46. On the basis of the results of this study, the personnel for the course could be limited to one half-time student assistant, which would lower personnel expenditures for the course to $350.00 per

month, or $875.00 per quarter. Added to the computer costs, total operational costs are lowered to $1,739.46, or about half of the initial operational expenses.

b. What did library materials and handouts for the course cost?

Books purchased for the CMI course cost $264.40. After eliminating those references considered of no value, it would cost $229.80 to set up a similar library. Handouts cost $150.00 and were listed under instruction. This expense could be eliminated by charging the student for the manual for the course.

Cost of reproducing the reference materials, like the cost of books, is an initial expense which would not be repeated.

c. How much did it cost to operate the course in terms of cost per student hour of credit?

The initial operating expenses for the first run of the course cost $20.16 per credit hour. A second run would cost $12.10 since the course has been approved as a 5 hour course. When only ongoing costs are analysed (personnel and computer time), the cost drops to $5.90 per credit hour for a five hour course.

d. How did CMI cost compare with conventional classroom instruction?

University allocations for the 5 hour course for 59 students would be $10,350.00, or $35.10 per credit hour. This is compared to the $5.90 per credit hour required to teach the CMI version of the course.

Evaluation Instruments

Analysis of the testing data from the CMI course was difficult because criterion-referenced materials were used, and the resulting distributions were highly skewed. The relationship between tests did not present the needed normal distributions for statistical analysis.

The data indicated relatively useful midterm and computer tests. The correlations between related questions on the midterm and the computer tests, though deflated due to non-linear relationships, present a unique result. On seven units, those students who missed the the most questions on the computer appeared to achieve the greatest number of points on the midterm, which may indicate that the computer presentation was a learning experience for the students.

In summary, students for the most part were unable to define a set schedule for completion of the course units, but studied for them in a random fashion. The findings indicate that students in this CMI course were able to perform as well as those in a traditional class. Those students given more control of the learning situation achieved higher scores on the computer tests and final product, and had a higher attitude score toward CMI.

The role of the instructor was viewed predominately as that of source expert and guidance counselor, with a secondary role as evaluator.

The CMI logic appeared to perform as intended, while data on student progress aspects were lacking. Materials prepared for the course appeared to serve the needs of the students who left with

relatively favorable attitudes toward computer-managed instruction.

Cost effectiveness data indicates that presentation of this course via CMI greatly reduced the operational cost per credit hour of instruction.

There were a few unusual findings. The self-sequenced computer-evaluated group took less time to complete the computer dialogue than the other groups. This group evaluated their own products on the terminal, which should have required more terminal time. The reason for the lower time may be that this group chose the units they were prepared for and were able to proceed without delay. However, the self-sequenced instructor-evaluated group should, for the same reason, have had a mean terminal interaction time less than that of the self-sequenced computer-evaluated group. This was not the case, however.

Students expressed a preference for more interaction with the course professor. This contrasts with the actual number of interactions with the professor. Even though he was available, students did not go to see him as much as they indicated they wanted to.

Students' bids were fairly consistent throughout the first thirteen units. They made little change in predicting their own ability to accomplish a unit, possibly because graduate students are well aware of their ability to perform and therefore consistent in their estimation of success.

Midterm scores for the group who changed the sequence of the units more than three times were higher than for those who were given

the opportunity, but did not change the sequence. However, the latter group performed better on the final product. At first glance this may appear to be inconsistent, but may point to the need for the set-sequence in relation to productive unit presentation.

CHAPTER IX

SUMMARY AND RECOMMENDATIONS

The use of CMI for a course of study was facilitated by the organization of the material for the course in line with the "Systems Approach" requirements. Behavioral objectives were set up, indicating to the student what was expected of him during the course of instruction. The use of the computer in the course for monitoring student experiences facilitated recordkeeping and data collection, and gave immediate knowledge to students about their position in relation to course requirements. Immediate scoring and presentation of necessary remedial information was facilitated since the tests were part of the computer presentation.

Costs of operation were lower than those of a traditionally taught class. Students using self-sequenced computer-facilitated evaluation were able to move through at their own pace, with no loss in learning or productivity, and with only minimal interaction with the professor. Individualized instruction gave the student the opportunity to explore, without the usual confinement of specified class-lecture schedules and lock-step course assignments.

Computer-managed instruction, in which instruction is by individualized pursuit of goals, with testing and management aspects

programmed on the computer, facilitated the educational process and provided for a self-directed approach to learning.

Future Research Using This CMI Logic

The current investigation was undertaken to implement a CMI course of study, and to explore learning variables using the course as a tool. The logic developed for this CMI could be used with any set of instructional materials which have been organized and can be evaluated using true-false and multiple-choice questions. Appropriate unit descriptions, test questions and criteria would replace the existing ones.

Future users of the course logic could make several changes in the CMI system to make it operate more effectively. Separate counters could more accurately record the units completed and be available in a useful form on the users file. A quick examination of switch settings would indicate those units chosen by the student. Also, a proctor message could indicate to the instructor when a student had completed a unit, which objectives were missed, and how many questions per objective were missed. This could be used at the end of the day to up-date student records.

Student performance on midterm and final product evaluation, and attitudes toward CMI were basically the same for the four treatment groups, with slightly higher means and slightly lower terminal time registered by the self-sequenced group. In terms of cost effectiveness, it would appear that the most efficient method for a student to proceed through a course of this type would be to choose his own sequence and

receive the computer-facilitated evaluation for his written product. This could mean that the course instructor would fill the role of guidance and counceling expert, source expert and lecturer or small group discussion leader as needed, and evaluation expert at the conclusion of Unit 20. The professor's time could be spent at tasks other than lecturing at appointed class sessions.

The evaluation role of the instructor presents a problem for the system currently in operation in educational institutions if they use this form of CMI. A class of 20 or 30 students would present little hardship to the professor in terms of end of the quarter evaluation. However, if the class membership numbered in the hundreds, as it well could with this type of CMI presentation, the end of the quarter evaluation could pose a hardship for the professor. For this reason, it would be to the advantage of both professor and student if the student could enter and finish the course at any time during the year, thus staggering the termination date and end-of-course evaluations.

Since self-sequencing appeared to have some effect on the student's performance, it might be that the productive and cognitive aspects of this course could be separated as independent programs. A student could choose either the cognitive test or the productive criteria for any unit at any time, allowing him even greater freedom of choice than self-sequencing alone. Also, the course could be offered for variable credit. A student interested only in the cognitive aspects of the systems approach could take the first 13 units

and the midterm for fewer credits than the student who desired both the cognitive and productive aspects of the course. It would be difficult to produce only the products without the cognitive work, unless the student had had prior experience with the systems approach.

The use of BID with this graduate course did not prove as motivational as anticipated. Students felt it was a threat, since 20% of their final grade was to be based on their final BID total. This game could possibly be more effective if used strictly as a motivational device and unrelated to the course grade.

With the information gained from the students' evaluation of the references, the resource materials used in the course can be greatly reduced, with those retained providing sufficient information for the students to meet the objectives.

The influence of the CMI presentation extended to many colleges of the university. Those professors who served as subject matter experts planned for future classes to use the PI texts generated by the students in this course. They are also aware of CMI and how it can be used.

In summary, a computer-managed sequence of instruction, as developed and implemented in this study, can reduce the cost of educating graduate students with no loss in learning taking place when compared with the traditional class. Future studies can build on the findings presented here and possibly even increase the amount information retained by the students.

APPENDIX A

BID: A GAME OF SELF-DIRECTED LEARNING

APPENDIX A

BID: A GAME OF SELF-DIRECTED LEARNING

By Thorwald Esbensen*

PURPOSE:

1. To give each player practice in assessing his ability to accomplish designated learning tasks, and
2. To increase each player's motivation to accomplish the learning task.

ROLES:

1. Teacher

   a. Write performance objectives for the course.
   b. Be available during specific office hours to assist student with any problems related to the course.
   c. Provide subjective evaluation criteria for student's written material.

2. Student

   a. Work on task.
   b. BID on points representing his assessment of his ability to accomplish the task.
   c. Keep records of his own on task BID for passed or failed and total points.
   d. Write, in stages, a product which will be the major requirement of the course. The product is to be graded as each step is completed. No BID points will be used in product evaluation.

3. Computer

   a. Introduce student to the game BID and the computer.
   b. Present tasks, tests, and evaluate results.
   c. Indicate when remedial work is necessary to pass test.
   d. Keep score of BID points for each student, for Units 1 through 13.

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*The version of the game, BID, is an adaptation of the one designed by Esbensen (1969).

OBJECTS OF PLAY:

1. Score Sheet.
2. Contract Sheets.
3. Bibliography.
4. Reference material in the Library.

NATURE OF COMPETITION:

1. Student competes with himself for points.
2. Game is non-zero-sum.
3. The first ten students who successfully complete a unit are placed on an EXPERT list, available on the computer for reference by the other students. Assistence by the EXPERTS is strictly voluntary.

RULES OF PLAY:

1. Student contracts for a unit.
2. Student examines the Contract Sheet for that unit. He;
   a. notes objective(s) of the unit,
   b. checks references.
3. Student performs the necessary study to prepare himself for passing the test on the objective(s).
4. Student returns to the terminal and takes the test.
5. Student may avail himself of the teacher's time whenever he needs assistance. He may also use other students and/or EXPERTS for assistance.
6. Student writes material at each step which will be used to produce the product for the course. This will be graded Pass or Fail as each step is completed.
7. Units 1 through 13 must be comp eted before the student can receive a passing grade for the course.

SCORING PROCEDURE:

1. Student begins with 20 points.
2. For each unit he may BID from 1 to 10 points on his assessment of his ability to receive a pass on the unit test.
3. If he passes, he adds the points to his running total; if he fails, he subtracts the points. For example:

Contract Number	Value BID(1-10)	Test Results	PASS: Add Score	FAIL: Subtract Score	Total Running Score
					20
1	5	pass	+5		25
2	7	fail		-7	18
2	5	pass	+5		23
3	8				

4. The computer will also keep score, but it is recommended that the student keep track for his own reference as to where he is and where he is going.
5. Total Possible Points -- 150.
   a. A total of 20% of the final grade will depend on BID points earned.
6. Additional BID points may be earned by the student for turning in one-page summaries of pertinent topics.

BID SCORE SHEET

Contract Number	Value BID(1-10)	Test Results	PASS: Add Score	FAIL: Subtract Score	Total Running Score +20

UNITS 1 2 3 4 5 6 7 8 9 10 11 12 13

Circle number when chosen--(8) through when test is passed--(8).

APPENDIX B

CONTRACT SHEET

APPENDIX B

CONTRACT SHEET

UNIT 7

IDENTIFY BEHAVIORAL OBJECTIVES WHICH HAVE BEEN WRITTEN CORRECTLY. WRITE BEHAVIORAL OBJECTIVES FOR YOUR AREA OF INSTRUCTION.

Productive Behavioral Objective

Student is to write Behavioral Objectives for each unit according to the three required elements for behavioral objectives.

Cognitive Behavioral Objective 1

The student will be able to identify correct descriptions, the necessary conditions and specific characteristics of a behavioral objective.

Cognitive Behavioral Objective 2

Given sample objectives, the student will be able to identify the components which are missing.

References

Primary

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70. Mager, R. F. Preparing instructional objectives. pp. 1-60.

Secondary

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385. Deterline, W. A. The secrets we keep from students. pp. 7-10.

485. Kapfer, M. B. Behavioral objectives and the gifted. pp. 14-16.

55. Lindvall, C. M. Defining Educational Objectives. pp. 1-77.

APPENDIX C

TEST QUESTIONS

APPENDIX C

TEST QUESTIONS

UNIT 7

Behavioral Objective 1

The student will be able to identify correct descriptions, the necessary conditions and specific characteristics of a behavioral objective.

Questions

070101 One of the major reasons for using behavioral objectives is that they allow the teacher to be more efficient in evaluating the effect of instruction.

a. True b. False

070102 Behavioral objectives describe:

a. how the learner will undertake a learning sequence.
b. what a learner will do upon completing a learning sequence.
c. the methodology that will be utilized by the teacher.
d. All of these.

070103 In a well stated behavioral objective, which of the following should be identified by name and defined in words of action?

a. criterion test
b. criterion performance
c. observable response
d. important conditions

070104 Which of the following terms should not be used when writing behavioral objectives?

a. measure b. list c. contrast d. comprehend

070105 The terms behavioral objective and instructional objective are:

a. interchangeable.
b. lower and higher order objectives, respectively.
c. unrelated to each other.
d. similar, but used differently.

Behavioral Objective 2

Given sample objectives, the student will be able to identify the components which are missing.

Questions

070216 "Given a list of 3 behavioral objectives, the student will be able to orally state which component(s) are missing, with 100% accuracy."

The following is missing:

a. important conditions
b. observable behavior
c. criterion performance
d. nothing

070217 "Given a list of 50 state capitals, the student will demonstrate that he knows the respective states with 100% accuracy."

The following is missing:

a. observable response
b. important conditions
c. criterion performance
d. nothing

070219 "With 90% accuracy, the student will be able to arrange words (in writing) in alphabetical order according to the beginning letter of each word."

The following is missing:

a. observable response
b. criterion performance
c. important conditions
d. nothing

070225 "The student will, by sight, correctly identify all (26) letters of the alphabet."

The following is missing:

a. observable behavior
b. important conditions
c. criterion performance
d. nothing

070226 "The student will write the names of the last 10 Presidents of the United States with 100% accuracy."

The following is missing:

a. observable response
b. important conditions
c. criterion performance
d. nothing

APPENDIX D

PRETEST FOR PROGRAMMED INSTRUCTION COURSE

APPENDIX D

PRETEST FOR PROGRAMMED INSTRUCTION COURSE

The following is a brief examination which will help us in determining your prior knowledge on some of the topics that will be taught in this course. Please work as quickly as possible, answering as many of the questions as you can. Do not be discouraged if you cannot answer many of the questions since all of the needed information will be presented throughout the term.

1. Briefly explain what is meant by the use of the Systems Approach in the design of instructional materials.

2. List, in order, the seven steps in Dick's Systems Approach Model.

3. List the three elements basic to all Systems Approach models.

4. List at least three of the basic requirements necessary in choosing a subject matter area to be programmed.

5. Briefly define:

   Frame -

   Cue -

   Response mode -

6. Briefly differentiate between programmed instruction material and non-programmed material.

7. Define task analysis in reference to instruction design.

8. List three characteristics of the learner that are considered as Entry Behaviors.

9. Briefly define:

   Discrimination Frame -

   Baboon Frame -

   Constructed Response Frame -

10. List the three necessary conditions of a well written behavioral objective.

11. List Gagné's eight conditions of learning.

12. Briefly define:

   Intrinsic Programming -

   Extrinsic Programming -

   Adaptive Programming -

13. List at least two reasons for selecting a particular programming strategy.

14. List five characteristics of well-written test items.

15. Name two types of formative evaluation.

16. List the differences between using the Systems Approach in developing materials for programmed instruction and materials for any other medium.

* * * * *

APPENDIX E

MIDTERM EXAMINATION FOR PROGRAMMED INSTRUCTION COURSE

APPENDIX E

MIDTERM EXAMINATION FOR PROGRAMMED INSTRUCTION COURSE

This examination covers the thirteen cognitive units of the programmed instruction course. Read and answer all questions carefully.

1. Briefly explain the major use of the Systems Approach in Education.

2. List, in order, the steps in Dick's or Hansen's Systems Approach Model.

3. List the three elements basic to all Systems Approach Models.

4. List five of the basic requirements necessary in choosing a subject matter area to be programmed.

5. Briefly define:

   a. Step size--
   b. Explicit response--
   c. Feedback--
   d. Prompt--

6. Name three characteristics that differentiate programmed instruction material from non-programmed material.

7. Define task analysis in reference to instructional design.

8. Briefly define what is meant by entry behavior (give examples).

9. Briefly define:

   a. Baboon frame--
   b. Discrimination frame--
   c. Confirmation frame--
   d. Sub-terminal frame--

10. A well written behavioral objective contains:

11. List and briefly define Gagné's eight levels of learning.

12. Briefly define:

    a. Adjunct programming--
    b. Extrinsic programming--
    c. Intrinsic programming--
    d. Linear programming--

13. List at least two programming strategies and reasons for selecting each.

14. List and define at least four types of test items.

15. List five characteristics of a well-written test item.

16. Briefly differentiate between formative and summative evaluation.

17. List the differences between using the Systems Approach in developing materials for programmed instruction and materials for any other medium.

* * * * *

APPENDIX F

PRODUCTIVE CRITERIA

APPENDIX F

PRODUCTIVE CRITERIA

UNIT 7

Productive Behavioral Objective

The student is to write behavioral objectives for each unit according to the three required elements for behavioral objectives.

Criteria

1. Do you have a behavioral objective for each sub-task on the task analysis?

2. Is the performance in observable student behavior terms (in action verbs)?

3. Did you use words such as: know, comprehend, realize, understand?

4. Do all behavioral objectives state the conditions under which the behavior is to occur?

5. Do all behavioral objectives state performance level?

6. Are your behavioral objectives relevant?

PASS:_____

FAIL:_____

APPENDIX G

PROJECT EVALUATION SHEET

APPENDIX G

PROJECT EVALUATION SHEET

	Extra Points	Points
1. Task Analysis (10)		____
2. Behavioral Objectives (10)		____
a. Comparison with conventional curricula (1)	____	
b. Outline of contents of program (1)	____	
c. Show limits of the program's objectives and area not being developed by the program (1)	____	
3. Description of Entry Behaviors (5)		____
4. General Description of Target Population (5) (Not entry behaviors)		____
a. Minimum grade on standardized ability or aptitude tests (1)	____	
5. Program Preparation (Description of preparation process) (10)		____
a. Expert Opinion (1)	____	
b. Revision based on one-on-one (1)	____	
6. Evaluation Plan (Preparation for evaluation, data collection and development of instruments) and report of data (error rate of program and testing) (10)		____
a. Relationship of field test and target population (1)	____	
7. Revision Suggestions or Implications (10) (Based on Report of Data in #6)		____
8. Miscellaneous (General overall impressions) (5)		____
a. Indications of student attitude (1)	____	
b. Practicality of program, e.g., supplemental materials, reusability, costs, etc. (1)	____	
c. Administration, e.g., conditions necessary for success, procedures for introducing students to program, etc. (1)	____	
TOTAL		____

APPENDIX H

COMPUTER FLOW CHART SHOWING LOGIC OF CMI COURSE

APPENDIX H

COMPUTER FLOW CHART SHOWING LOGIC OF CMI COURSE

The components of the CMI course were logically oriented and are presented in the flow chart in Figure . The experimental components are also presented in order to illustrate their relation to the entire course sequence.

Switch 22 was used as a means of sequencing the material. A one (1) indicated that the student was able to choose any unit in any sequence he chose. By setting switch 22 to zero (0) the student was sequenced from Unit 1, to Unit 2, and so on to Unit 20.

Switch 23 was used as a means of providing evaluation criteria for the products to be written by the student. One (1) in switch 23 indicated that the student would be presented the criterion questions via the computer, while a zero (0) indicated that the student would receive the evaluation from the instructor. These two switches were used as a means of branching the four experimental groups used in the design of the study.

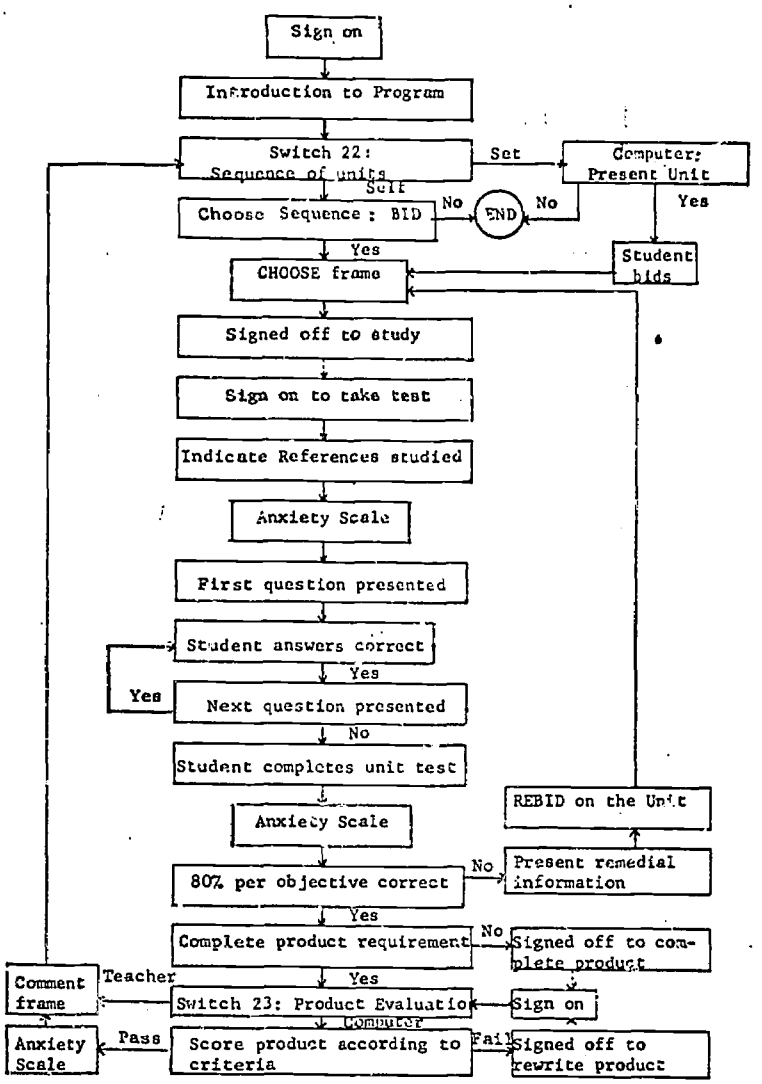


Figure 4. Computer Logic Flow Chart for CMI System.

APPENDIX I

PROGRAM PRESENTATION

APPENDIX I

PROGRAM PRESENTATION

UNIT 7

(The following information was presented to the student when he chose Unit 7. C: computer dialogue; S: student response.)

C: Unit 7

Identify behavioral objectives which have been written correctly.

Write behavioral objectives for your area of instruction.

Your BID for this unit is:

S: 10

C: Do you wish information on any of the following? If so, please type in the appropriate letter.

a. EXPERTS--Students who have completed the unit you are currently working on who might be able to help you.

b. MESSAGES--Information pertinent to class (lectures, reschedules, and so forth).

c. UNITS--A listing of units you have chosen to date.

d. NO CHOICE--Branch to next frame.

S: d

C: You will now be signed off to go study for the next unit. When you feel you are ready to continue with the program, return to the computer and sign on, please. Check your task analysis to determine if you must:

a. study for a test
b. write material for your program
c. do both a and b

(The student was then signed off to go study. When he returned to the terminal, he was presented the following.)

C: Your name is:

Joe Doe

Have you signed-on to your own program?

a. Yes b. No

S: Type a or b.

C: a

You will now be given the test on

Unit 7

If this is incorrect, you chose and/or studied a different unit, type in the letter e, for error.

If this is correct, space to continue with the test.

S: (Space)

C: In order to evaluate the reference material which has been presented for you to study, it is necessary for you to answer the following questions. In refering to a reference, such as that of Mager, Preparing Instructional Objectives, you are to type in only the number of that reference as it appears in the Bibliography. The numbers for the references also appear before each of the references in each unit. When you have typed in a number, space, then type in another, space, and so forth.

Space to continue.

S: (Space)

C: Remember to type in only the number(s) and space after each number.

1. Which references did you study for this unit?

S: 12 32 69

C: 2. Which references were of no value in studying for this unit?

S: 12

C: 3. Which references were of the most value in studying for this unit?

S: 32

C: The following statements were made by some students describing the way they felt while working on the section you have just completed.

Press the space bar to continue.

S: (Space)

C: I am tense
1. not at all 2. somewhat
3. moderately so 4. very much so
Type the number to the left of the statement to indicate how you felt during the section of the course you have just finished.
Remember: indicate how you felt.

S: 1

C: I feel at ease
1. not at all 2. somewhat
3. moderately so 4. very much so

S: 2

C: I am relaxed
1. not at all 2. somewhat
3. moderately so 4. very much so

S: 4

C: I am jittery
1. not at all 2. somewhat
3. moderately so 4. very much so

S: 1

C: I feel calm
1. not at all 2. somewhat
3. moderately so 4. very much so

S: 4

C: The first question now follows.

In a well stated behavioral objective, which of the following should be identified by name and defined in words of action?

a. criterion test
b. criterion performance
c. observable response
d. important conditions

S: a

C: c is the correct answer. Space, please.

.
.
.

"Given a list of 50 state capitals, the student will demonstrate that he knows the respective states with 100% accuracy."

The following is missing:

a. observable response
b. important conditions
c. criterion performance
d. nothing

S: a

The following statements were made by some students describing the way they felt while they were working on the section you have just completed.

(The student was then presented the anxiety scale, as before, after which he received the following remedial information.)

C: You should study references for Behavioral Objective 1. Space to continue.

You must rebid on this unit since your errors were more than 20 percent. Type your bid.

S: 3

C: You will now be branched to CHOOSE. When you return to take the test, you will be tested on those objectives you missed. Space, please.

S: (Space)

C: Do you wish information on any of the following? Please type in the appropriate letter.
a. EXPERTS--Students who have completed the unit you are currently working on who might be able to help you.
.
.
.

(The student would then be signed off to restudy for Unit 7. When he passed all objectives for the unit, he would be given the criteria questions for the productive behavioral objective as follows.)

C: The following criteria are to be used in order for you to evaluate your written product for this unit. You must score it pass or fail.

Criteria:

1. Do you have a behavioral objective for each sub-task on the task analysis?

S: yes

C: 2. Is the performance in observable student behavior terms (in action verbs)?

S: yes

C: 3. Did you use words such as: know, comprehend, realize, understand?

S: no

C: 4. Do all behavioral objectives state the conditions under which the behavior is to occur?

S: yes

C: 5. Do all behavioral objectives state performance level?

S: yes

C: 6. Are your behavioral objectives relevant?

S: yes

C: Now you are to indicate whether you have passed or failed this product evaluation.

a. Pass b. Fail

S: a

C: COMMENT FRAME. Type and enter each comment. When you have completed all comments, type $ and enter it.

(The student could then enter any pertinent comments about the unit he had just finished.)

S: $

C: This is where you choose the unit you will work on next. Type the letter associated with the unit of your choice.

a.	Unit 1	k.	Unit 11
b.	Unit 2	l.	Unit 12
c.	Unit 3	m.	Unit 13
d.	Unit 4	n.	Unit 14
e.	Unit 5	o.	Unit 15
f.	Unit 6	p.	Unit 16
g.	Unit 7	q.	Unit 17
h.	Unit 8	r.	Unit 18
i.	Unit 9	s.	Unit 19
j.	Unit 10	t.	Unit 20

S: h

C: Please type in again. Check accuracy.

S: h

(The student was then branched to Unit 8, and the same general format was followed as was presented for Unit 7.)

APPENDIX J

GENERAL INFORMATION QUESTIONNAIRE

APPENDIX J

GENERAL INFORMATION QUESTIONNAIRE

Name_____

Social Security Number _____ Age _____

Major _____ Minor _____

Highest Degree_____

Graduate Record Exam -- MATH _____ ENGLISH _____

Present GPA _____ Taking Course for Credit _____Audit__

Phone _____

Have you completed any of the following courses? (Check if yes)

_____ A. EDR 540 - Briggs
_____ B. EDR 660 or 552 - Esbensen
_____ C. Other courses relating to programmed instruction (Explain)

Have you read any of the following books? (Check if yes)

_____ A. Instructional media - Briggs
_____ B. Sequencing of instruction - Briggs
_____ C. The Psychology of learning and instruction - DeCecco
_____ D. An introduction to programmed instruction - Deterline
_____ E. Working with individualized instruction - Esbensen
_____ F. Developing programmed instruction materials - Espich & Williams
_____ G. Teaching machines and programmed instruction - Fry
_____ H. The Conditions of learning - Gagné
_____ I. Teaching machines and programmed instruction II - Glaser
_____ J. A Guide to programmed instruction - Lysaught & Williams
_____ K. Preparing instructional objectives - Mager
_____ L. Good frames and bad - Markle
_____ M. Learning and programmed instruction - Taber, Glaser, & Schaefer
_____ N. Other related books (List below)

APPENDIX K

STUDENT ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION

APPENDIX K

STUDENT ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION

Developed by Bobby R. Brown

This is not a test of information; therefore, there is no one "right" answer to a question. We are interested in your opinion on each of the statements below. Your opinions will be strictly confidential. Do not hesitate to put down exactly how you feel about each item. We are seeking information, not compliments; please be frank.

Name:_____ Date_____

Name of Course_____ Student Number _____

CIRCLE THE RESPONSE THAT MOST NEARLY REPRESENTS YOUR REACTION TO EACH OF THE STATEMENTS BELOW:

1. While taking Computer Managed Instruction I felt challenged to do my best work.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

2. The material presented to me by Computer Managed Instruction caused me to feel that no one really cared whether I learned or not.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

3. The method by which I was told whether I had given a right or wrong answer became monotonous.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

4. I was concerned that I might not be understanding the material.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

5. I was not concerned when I missed a question because no one was watching me anyway.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

6. While taking Computer Managed Instruction I felt isolated and alone.

All the time	Most of the time	Some of the time	Only occasionally	Never

7. While taking Computer Managed Instruction I felt as if someone were engaged in conversation with me.

All the time	Most of the time	Some of the time	Only occasionally	Never

8. The responses to my answers seemed appropriate.

All the time	Most of the time	Some of the time	Only occasionally	Never

9. I felt uncertain as to my performance in the programmed course relative to the performance of others.

All the time	Most of the time	Some of the time	Only occasionally	Never

10. I found myself just trying to get through the material rather than trying to learn.

All the time	Most of the time	Some of the time	Only occasionally	Never

11. I knew whether my answers were correct or not before I was told.

Quite often	Often	Occasionally	Seldom	Very Seldom

12. I guessed at the answers to questions.

Quite often	Often	Occasionally	Seldom	Very Seldom

13. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

14. I was encouraged by the responses given to my answers of questions.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

15. As a result of having studied some material by Computer Managed Instruction, I am interested in trying to find out more about the subject matter.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

16. In view of the time allowed for learning, I felt too much material was presented.

All the time	Most of the time	Some of the time	Only occasionally	Never

17. I was more involved in running the machine than in understanding the material.

All the time	Most of the time	Some of the time	Only occasionally	Never

18. I felt I could work at my own pace with Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

19. Computer Managed Instruction makes the learning too mechanical.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

20. I felt as if I had a private tutor while on Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

21. I was aware of efforts to suit the material specifically to me.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

22. I found it difficult to concentrate on the course material because of the hardware.

All the time	Most of the time	Some of the time	Only occasionally	Never

23. The Computer Managed Instruction situation made me feel quite tense.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

24. Questions were asked which I felt were not relevant to the material presented.

All the time	Most of the time	Some of the time	Only occasionally	Never

25. Computer Managed Instruction is an inefficient use of the student's time.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

26. I put answers in knowing they were wrong in order to get information from the machine.

Quite often	Often	Occasionally	Seldom	Very Seldom

27. Concerning the course material I took by Computer Managed Instruction, my feeling toward the material before I came to Computer Managed Instruction was:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

28. Concerning the course material I took by Computer Managed Instruction, my feeling toward the material after I came to Computer Managed Instruction is:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

29. I was given answers but still did not understand the questions.

Very often	Often	Occasionally	Seldom	Very seldom

30. While on Computer Managed Instruction I encountered mechanical malfunctions.

Very often	Often	Occasionally	Seldom	Very Seldom

31. Computer Managed Instruction made it possible for me to learn quickly.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

32. I felt frustrated by the Computer Managed Instruction situation.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

33. The responses to my answers seemed to take into account the difficulty of the question.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

34. I could have learned more if I hadn't felt pushed.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

35. The Computer Managed Instruction approach is inflexible.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

36. Even otherwise interesting material would be boring when presented by Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

37. In view of the effort I put into it, I was satisfied with what I learned while taking Computer Managed Instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

38. In view of the amount I learned, I would say Computer Managed Instruction is superior to traditional instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

39. With a course such as I took by Computer Managed Instruction, I would prefer Computer Managed Instruction to traditional instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

40. I am not in favor of Computer Managed Instruction because it is just another step toward de-personalized instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

APPENDIX L

INFORMATION QUESTIONNAIRE

APPENDIX L

INFORMATION QUESTIONNAIRE

Please be straight forward in your appraisal of your attitudes toward this class. The material will not be analysed prior to turning in grades. Read and answer every one of the questions, Please. Your responses will assist in the revision and evaluation of the course.

Circle the number to the left of your choice, as:

Do you like rain?
(1) Yes, very much
2 Sometimes
3 Not at all

When comments are required, be precise.

- -

1. What was the one most important feature of the course in terms of content?

2. What was the one least important feature of the course in terms of content?

3. What was the one most important feature of the course in terms of procedures?

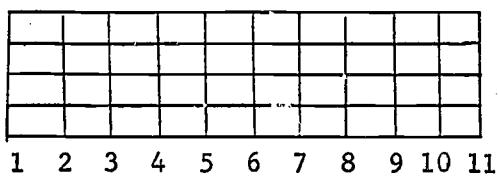
4. What was the one least important feature of the course in terms of procedures?

5. Graph your attitude toward this course as the term progressed.

VERY FAVORABLE

INDIFFERENT

VERY UNFAVORABLE



6. What grade do you expect in this course? _____

7. What was your attitude toward your grade for this course at the beginning of the quarter?

1 Very concerned
2 Somewhat concerned
3 Not at all concerned

8. What is your attitude NOW toward grades for this course?

   1 Very concerned
   2 Somewhat concerned
   3 Not at all concerned

9. Would you take another course by Computer Managed Instruction?
   1 Gladly
   2 Possibly
   3 Reluctantly
   4 Never

10. Did you feel you learned what was expected of you as indicated by the behavioral objectives? _____ Comment:

11. Do you feel the material in this course was relevant to your professional goals?
   1 More relevant than other courses
   2 As relevant as other courses
   3 Less relevant
   4 Not at all relevant to my goals

12. Would you have preferred "text and lecture classes?"
   1 Absolutely, for this course
   2 Maybe
   3 Not at all for this course

13. Did you feel you had too much work to do in this course?
   1 Way too much
   2 More than most courses, but not too much
   3 Same as most courses
   4 Less than most courses
   5 Not enough work

14. In what ways did you interact with the professor in the course? Circle as many as are appropriate.
   1 Source expert -- he assisted in locating needed information
   2 Counseling and guidance -- assisted in making decisions
   3 Group leader -- for small group discussions, lecture
   4 Evaluation expert -- merely scored papers
   5 Not at all

15. Approximately how many times did you interact with the professor?

_____

16. In what ways did you interact with the graduate assistants in the course? Circle as many as are appropriate.
    1 Source expert -- assisted in locating needed information
    2 Counseling and guidance -- assisted in making decisions
    3 Group leader -- for small group discussions, lecture
    4 Evaluation expert -- merely scored papers
    5 Not at all

17. Approximately how many times did you interact with the assistants?

    _____

18. Approximately how often did you ask fellow students for help or discuss problems? _____

19. What was the result of 18? (Use back of page for comments.)

20. Were you able to find the material needed to meet the objectives?
    1 All of the time
    2 Most of the time
    3 Sometimes
    4 Rarely
    5 Never

21. Do you think this class should have met:
    1 Every period designated for the class
    2 Every other period
    3 One hour a week
    4 Not at all
    5 Other _____

22. Regardless of the source (computer or graduate assistant), do you feel that the criterion questions for the products you wrote were:
    1 Extremely relevant
    2 Most were relevant
    3 Some were relevant
    4 Lacked some relevance
    5 Extremely irrelevant

23. Also, were the criterion questions:
    1 Extremely adequate
    2 Most were adequate
    3 Some were adequate
    4 Lacked some adequacy
    5 Extremely inadequate

24. Do you feel that the product for UNIT 20 is the best you could produce?
    1 Extremely confident that it is
    2 Quite confident
    3 Average
    4 Not very confident
    5 Not at all confident that it is

25. Do you feel that the TESTS on the computer were a learning experience?
    1 Very much so
    2 More than most tests
    3 About average
    4 Less than most tests
    5 Not at all

26. Which UNIT TESTS did you fail at least once? (Not those you had to take again due to machine errors.)

    1 2 3 4 5 6 7 8 9 10 11 12 13

27. Which UNITS did you fail due to poorly or improperly written questions?

    1 2 3 4 5 6 7 8 9 10 11 12 13

28. Your final BID total according to your calculations: _____

29. On UNIT 13, your calculations gave a BID total of: _____
    The computer gave you a BID total of: _____

30. Comment on your reaction to BID during the first 13 Units.

31. Describe how you paced yourself through the course (fit it into the requirements of other courses, so many Units per week, etc.)

32. When were you most prone to schedule time at the CAI terminal?
    Days:
    Hours:

33. Ideally, how and when would you have liked to have had terminal time made available to you?
    How:

    When:

COMPUTER-EVALUATED GROUP ONLY

34. Circle those units on which you felt the least competent when evaluating the product for the unit.

2 4 5 7 8 10 11 14 15 16 17 18 19

35. Do you feel that you were able to adequately evaluate your own products according to the criteria presented on the computer? _____ Comment:

36. Would you have wanted more interaction with the instructor of the course--more feedback? _____ Comment:

* * * * *

APPENDIX M

GENERAL QUESTIONNAIRE SHEET

APPENDIX M

GENERAL QUESTIONNAIRE SHEET

What area did you initially choose to program? _____

Who was the expert (professor, etc.) you asked for assistance? _____

What area did you finally program?
(If same as above, write SAME.) _____

Who was the expert (professor, etc.) you asked for assistance?
(If same as above, write SAME.) _____

Please comment on your relationship with the expert you chose. Favorable, unfavorable, helpful, and so forth.

Use the remainder of this page to complain, praise, criticize, and cry. Do not fear, this page will be read after grades are turned in. We want an honest statement on anything you feel is pertinent to the class.

APPENDIX N

TIME RECORD

APPENDIX N

TIME RECORD

Date	Time: START	Time: END	TOTAL TIME	UNIT	CMI #	STUDENT NAME	SUMMARY OF HELP

APPENDIX O

BIBLIOGRAPHY FOR PROGRAMMED INSTRUCTION COURSE

APPENDIX O

BIBLIOGRAPHY FOR PROGRAMMED INSTRUCTION COURSE

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GLOSSARY

GLOSSARY

BID: A game of self-directed learning
An instructional game used to give players experience in judging their own abilities and provide motivation for learning. Originally developed by Thorwald Esbensen during the implementation of individualized instruction in the Duluth, Minnesota, public schools.

Cognitive
That part of instruction involved with the act or process of knowing; knowledge. Term used to distinguish the acquisition of knowledge from the utilization of that knowledge.

Computer-Assisted Instruction (CAI)
Refers to the use of a computer to present instructional materials to a student. Allows for immediate feedback, self-pacing, branching, and recordkeeping.

Computer-Managed Instruction (CMI)
Uses the capability of the computer to record the progress of a student through a learning sequence, providing guidance and control as dictated by the needs of the situation. CMI is further defined by the components in each specific system.

Contract
A student guide, containing descriptive unit title, behavioral objectives, and related references.

Conventional instruction
See Traditional

Coursewriter II
A programming language used to transform English statements into computer operable commands.

Criterion
A standard or established level of attainment which must be reached by the student. In the context of CMI, it usually refers to a test situation which is related directly to a course objective. (See criterion referenced testing.)

Criterion Referenced Testing
A testing situation in which a student is evaluated on how well he achieves the established criterion.

Data print-out
An organized collection of data produced for human inspection and analysis by the computer.

Data processing*
Any operation or set of operations performed on date which is generated in the student-terminal interaction.

Debug*
To test for, locate and correct errors.

Encode*
The process of transforming commands according to a specific code, suitable for input to the computer.

Feedback
Presentation of information to the student based on an analysis of his responses. This may be delayed or immediate.

Flow Chart*
A graphic representation for the solution of a problem; graphic display of the logic desired for a computer program presentation.

Individually Prescribed Instruction (IPI)
Instruction based on prior and initial capabilities of a student, prescribed according to the teacher's estimation of correct alternatives which match a student's profile.

Individualized Instruction
Adapting instruction to individual requirements, providing for self-directed learning, self-pacing, independent study, and one-to-one teaching when required.

Logic*
To condense representations and avoid the ambiguity of natural languages. The decision structure for computer processing of information.

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*Adapted from Jordain, P. B. Condensed computer encyclopedia. New York: McGraw-Hill Book Company, 1969.

Productive (Product)
That part of instructional sequences which deals with the use of prior learned knowledge in the writing or development of written materials.

Programmed Instruction (PI)
Narrowly defined as a method of presenting learning materials in frames which require responses from the student. Broadly defined as a method of presenting the instruction in an organized, systematic manner, with feedback to the student.

Segment*
A hardware defined portion of a storage area (track) having fixed data capacity.

Student-Terminal interaction
The use of a computer in which the student utilized a terminal for on-line dialogue with the computer.

Switch*
A hardware device for indicating that one of several alternative states or conditions have been chosen.

Systems Approach to the Development of Instructional Materials
A method, plan, or pattern, to use in order to prepare instructional materials. Most systems approach models include, as a minumum set of requirements, the establishment of objectives, presentation of instruction, evaluation, and feedback.

Task Analysis
A process for determining the subordinate learning tasks required for a given sequence of instruction. Assumes that a subordinate task must be completed prior to the learning of any superordinate task.

Technology
Materials which can be used to aid man's work; computer, globe, blackboard, pencil and paper, and so forth. Also sometimes used to refer to the systems approach for the design and utilization of instructional materials.

Terminal*
A device by which data can leave or enter a computer system; as used in CMI, a cathode-ray-tube display (similar to a TV screen) with alphanumeric typewriter keyboard.

Traditional

The type of situation encountered in schools which are teaching by the lecture method, from prepared texts, with one teacher per contained classroom.

User's file

The status of a student's performance record at the last sign off. A file automatically maintained by the computer in order to determine "where students are" in a set of computer presented materials, whether instructional or not.

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